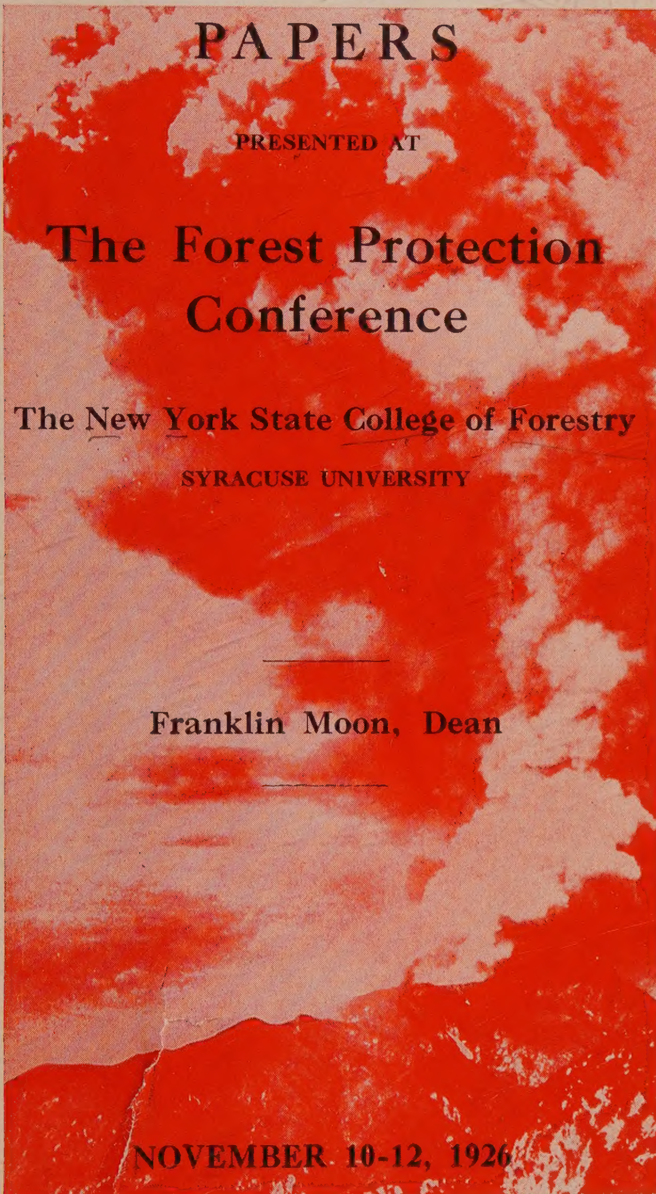

PAPERS

PRESENTED AT

The Forest Protection Conference

The New York State College of Forestry

SYRACUSE UNIVERSITY

Franklin Moon, Dean

NOVEMBER 10-12, 1926

THE FOREST PROTECTION CONFERENCE

New York State College of Forestry, Syracuse University
November 10-12, 1926.

THE Forest Protection Conference was held for the purpose of bringing to one forum the representatives of all agencies engaged in the work of protecting forest resources. The relationship of one to the other was more closely revealed at the Conference probably than ever before. The open discussions were not in any way secondary in point of interest to the excellent papers offered.

Doctor Haven Metcalf, senior pathologist in charge of the Office of Forest Pathology, United States Bureau of Plant Industry, Washington, D. C., seems to have sounded the keynote of the conference probably as well as it could be done. His brief and informal talk is therefore used as a foreword and introduction to this series of interesting papers. Dr. Metcalf's introduction has made it seem logical to place tree-disease subjects first and thus reverse the order in which the papers were read.

FUNGOUS DISEASES

By Doctor Haven Metcalf

In charge of Forest Pathology, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

I BELIEVE I am right in saying that this is the first Forest Protection Conference ever called in America. Many meetings have been called in the name of Forest Protection that were devoted wholly to fire protection, and of course there have been many devoted to individual problems of protection against particular diseases and insects. But a Forest Protection Conference that is really what the name implies—that considers all phases of the subject—is something new, and the New York State College of Forestry is to be congratulated on both the idea and its achievement.

Today we consider fungous diseases. I am sorry to say that it is my firm belief, based on twenty-five years of intimate contact with this subject, that fungous diseases in the forest are bound to increase in number and severity as time goes on, and trees, in the East particularly, assume more and more the status of cultivated plants. Reducing the cutting age will undoubtedly eliminate considerable loss from the heart rots, but even here there is much to indicate that second growth timber in many species and localities will show a lower critical age than virgin timber. The heavy losses are due from imported diseases. In our time we have seen the American chestnut reduced to a shrub by the Asiatic blight, and the reproduction of white pine made impossible over large areas by the European blister rust except where the rust is definitely controlled. There may have been earlier importations of this character: Who is prepared to prove, for example, that Sycamore anthracnose is a native disease? But let us not fool ourselves into the belief that all the imported diseases and pests exist for us in the past tense. I believe firmly that the future will bear me out in the saying that the enactment of Quarantine 37 marks the greatest single achievement in forest protection in this country up to date. But we can expect that there are fungi and insects still lurking undiscovered that obtained entrance to the continent while we were still free traders in pests and diseases. For example, what is this mysterious gall rust on Scotch pine in New York, recently discovered by Dr. York? No one has yet been able to name it. On present evidence we must consider it a stranger. What damage will it do? Will it spread to other hard pines, eastern or western? All we know now is that it is a bad actor with an incredibly high incidence of attack on individual trees of Scotch pine and that it apparently requires no al-

ternate host, hence would not be subject to control measures such as are employed in the case of the white pine blister rust. As to the future, let us remember that the gentle art of plant bootlegging is not unknown. I feel so certain that the Douglas fir canker, for example, will ultimately find its way to this continent that I have stationed a man in Scotland to work out the remaining details of its life history and become intimately familiar with the disease in advance of any possible outbreak in this country. What a difference it would have made in our dealings with chestnut blight and white pine blister rust if we had thoroughly studied in advance their exact identity and life history.

WHITE PINE BLISTER RUST IN NEW YORK

By Dr. H. H. York

Forest Pathologist, New York State Conservation Commission

White pine blister rust is a foreign invader. It has probably been in America at least 35 years. Its advent into this country was unseen. It came secretly buried in the inner living tissues of the bark of seedling white pine, which were imported from France and Germany. White pine blister rust was first found on cultivated black currants at the experiment station in Geneva, N. Y., in 1906, but it was not until three years later, 1909, that this disease was discovered on white pine in this country.

The First Conference

An employee of the Conservation Commission, while superintending the planting on state land of a shipment of seedling white pine which came from Germany, noticed that a golden yellow dust sifted out of small pustules on the stems of a number of the little trees. He recognized that something was wrong. At once he sent specimens to Mr. C. R. Pettis, state forester, who suspected they were blister rust and who immediately brought them to the attention of Dr. Perley Spaulding, forest pathologist in the office of Forest Pathology, United States Department of Agriculture. Dr. Spaulding pronounced them to be white pine blister rust. Soon after blister rust was found on the imported seedling white pine, Commissioner James S. Whipple of the Forest, Fish and Game Commission of New York called a conference of Federal forest pathologists, State and large private forestry interests to meet in New York City June 28, 1909, the first blister rust conference to be called in America. At this time, the American botanists, foresters and pathologists knew comparatively little about blister rust in Europe. A number of them had studied in German universities and must have seen or known something of the destruction which blister rust was causing in that country to white pine—the most widely planted of all exotic forest trees in Europe. Some of these gentlemen knew that millions of seedling white pine were being annually received in our own country from France and Germany. No one at the New York City conference apparently realized that blister rust was, at that time, so widely distributed in America and apparently, the fact that this disease is one of the most subtle of all plant diseases known in our country today had dawned upon no one. In

the report of a special committee appointed at this conference, the following occurs: "The subject for which the conference was called was thoroughly discussed and it is believed that no serious damage will occur, especially in view of the prompt action taken by all of the states represented in immediately proceeding to eradicate the danger caused by this disease in the few places it has been found." This same committee agreed that a complete eradication of the blister rust was possible at that time. Unquestionably the gentlemen who composed this committee were sincere but they were inexperienced in forest tree disease control work and they had not actually seen field conditions regarding white pine blister rust.

Immediately following the New York conference, a conference of officials from the Forest, Fish and Game Commission and the Department of Farms and Markets in New York was called in Albany to formulate and adopt a plan for stamping out blister rust in New York, the first state blister rust conference called in this country.

Protection Plan Outlined

The plan adopted at this conference was somewhat as follows: (1) To procure as complete a list as possible of every place to which Hein's white pine had gone during the two preceding years. "It is our desire to extend this list to include all other stock imported from Germany and France." (The white pine stock in which blister rust was discovered was from Hein's nurseries in Germany.) (2) "To inspect all such premises and destroy all ribes within 300 feet of such trees." This is the distance which the German pathologists claimed that blister rust would spread from currants and gooseberry bushes to white pine, but we know as the result of our field investigations that white pine is seriously damaged at a distance of one-half mile from cultivated black currants. Cultivated black currants are grown extensively in Europe and are the chief source of spread of blister rust in that continent. The German pathologists did not really know the distance-spread of blister rust from ribes to white pine. (3) "To keep close tab on cultivated currants and gooseberries in all districts of the state where suspicious pines were located and a closer watch on these bushes throughout the state after July 15." (4) "To destroy all suspicious or infected pine and ribes plants." (5) Suspicious plantings were to be thoroughly inspected during the latter half of May and first week of June.

Danger Recognized

The records of the Forest, Fish and Game Commission at this time showed that German nursery stock had been sent to 84 applicants in New York. These plantations were fairly well distributed over the state.

The records in the 1909 report of the Forest, Fish and Game Commission emphasize that the seriousness of blister rust was not to be under-estimated. This report states: "In Europe, according to Prof. Sommerville, the disease is so much on the increase that the outlook in that country for our white pine and other five needle American pines is almost hopeless. There are estates in England where hardly a white pine is left. In Denmark and in some parts of Russia, as near as Moscow, for instance, the raising of white pine had to be entirely given up on account of this rust. The same is true of Holland and portions of Germany."

Again we find in this report: "The people of this state have no cause for alarm because every known plantation made with German white pine in this state has been carefully examined, the ribes destroyed and inspection will be continued this coming spring. We can further say that every effort will be made by us to prevent importations of this pine. The disease is well under control and our only trouble will be to prevent nurseryman and private parties from importing."

Apathy and Antagonism Handicaps

Thus some pathologists and foresters at this time recognized that blister rust might become a serious menace to the successful production of white pine in America as a commercial timber crop. But the apathy and antagonism on the part of some botanists, pathologists and foresters, together with the hostility of nurserymen and the inertia of Congress, so delayed the requisite legislation that not until 1912, six years after the discovery of blister rust in this country, that the further importation of foreign nursery stock of white pine into the United States was prohibited. Meanwhile millions of seedling white pine, many of which had blister rust, had been received in America from Europe. These trees were widely planted throughout the Northeast and one small shipment from France was planted on Vancouver Island and which resulted in the permanent establishment of blister rust in the great Western white pine belts of America.

Toward the close of 1915, nine years after its discovery at Geneva, N. Y., blister rust was recognized by some individuals to be widely distributed throughout the Eastern white pine belt and was here for all time to come.

The real fight to control the spread of blister rust on a state wide scale throughout the Northeast may be said to have begun in 1916. This campaign was initiated with no real knowledge of how this disease was behaving in America. Nothing was known as to the conditions of its spread from ribes to white pine and from white pine to ribes. No systematic means of controlling blister rust had been devised. The little which was known about blister rust seemed to be accepted with all sorts of reservations. For example:

At a blister rust conference of the Northeastern states, held in September, 1916, the statement was made by a forest pathologist who had spent the entire summer of 1916 in the field, that blister rust could spread at least fifteen miles from white pine to ribes. This was a most conservative estimate yet this statement was skeptically received. We now know this disease may spread 150 to 200 miles from white pine to ribes.

Many Errors Made

As the result of an imperfect knowledge of the behavior of blister rust in America and the lack of any real control experiments on this disease, many errors of judgment were made, which today unfortunately reflect very unfavorably upon blister rust control work. For example:

The sowing of white pine seed in the New York nurseries was discontinued from 1916 to 1918 inclusive. The report of the Conservation Commission for 1917 states: "The use of white pine for planting is to be discontinued until some practical plan of disease control at a reasonable cost is worked out." The discontinuance of the sowing of white pine seed in the state nurseries and of the planting of this species produced such an unfavorable reaction against the use of white pine in reforestation and blister rust control work that there are yet those who would abandon the growing of white pine and in its place plant species of forest trees which are immune to blister rust. These persons are yet in the dark regarding the modern aspects of blister rust control, even though this work has been in progress for eight years and in 1926 was conducted on a broader scale than in any preceding year.

The gentleman who had direct charge of the field work in blister rust control in New York State in his report on this work in 1917 to the Superintendent of Lands and Forests states: "The damage caused in the various plantations where the disease has appeared is not great, so far as actual destruction of trees in the plantations is concerned, but the cost of controlling this disease in these plantations for the past eight years and the probable cost of controlling it until the plantations become merchantable, will probably be so great that there will be practically no profit derived from the money invested in making the plantations."

Relation of Ribes Not Well Known

While it was not absolutely known in 1917 that the aeciospores, which come from the stage of blister rust on white pine, will not reinfect white pine, it was very evident that wherever infected white pine occurred, there were ribes not far away and that these bushes bore the alternate stages of blister rust. It was also known that white pine did not have blister rust where there were no ribes.

Even had the author of the 1917 report been correct, there were not sufficient data at that time to warrant such a conclusion. The fallacy of this man's deductions is today common in the minds of many with forestry interests and is frequently met in blister rust control work.

It is apparent that a similar misconception of the practicability of blister rust control work is being disseminated today in classrooms of forest pathology as well as in many general courses on plant diseases.

In a manual which treats of forest tree diseases, the first edition of which appeared in 1918, the second in 1923, the following occurs: "In forested areas where wild currant and gooseberries are common, the further growing of white pine may have to be abandoned. The elimination of the bushes over extensive areas will probably never prove as profitable as planting or encouraging natural reproduction of other species of tree suited to the conditions. Where currants and gooseberries are not very abundant and the experiment of eliminating them is thought practical, results may be obtained if the work is vigorously prosecuted year after year."

How unfortunate it is that a verdict of this sort should have been rendered. It is typical of much we find in print today which are premature opinions or guesses and not facts. In 1918 it was too soon to pronounce judgment unfavorable or even favorable on the practicability of controlling white pine blister rust, but by 1923 it had been amply demonstrated that the spread of this disease can be effectively and economically controlled.

The attitude of mind and policies as expressed in the various citations were largely due in the beginning to a dearth of knowledge of white pine blister rust and the proper methods of its control and the lack of a realization of the necessity for practicing forest-tree-disease-control work in America. It is indeed unfortunate that these ideas still stick in the minds of many individuals and even more so when we recognize the fact that comparatively few foresters have really seen white pine blister rust and the results of the application of the proper measures of controlling this disease. If they are not willing to go out and be shown blister rust and refuse to accept the word of those who have seen and who have made the investigations on blister rust, they are not to be excused from adhering to false beliefs and from the misguidance of those who are to practice forestry in the future.

Much Research Required

As stated, at the beginning of blister-rust-control work, there was the unfortunate handicap of detail knowledge of the behavior of this disease in America. Its invasion was startling. We were inexperienced in forest tree disease control work. We had no experience upon which to draw. We had to devise and experiment, all of which required time. Many mistakes were unavoidably made.

The offices of Forest Pathology and Blister Rust Control have contributed much on the life history of Cronartium ribicola, its behavior in America and the practicability of its control, but with all this, more information concerning blister rust is urgently needed.

Repeatedly we are asked just how serious is blister rust? Has it not about run its course? Will not eradication of the ribes be a year in and year out job? Is it safe and practical to plant white pine because of blister rust. Can blister rust really be controlled?

It is absolutely essential to have accurate data in answer to these questions in order that the Conservation Commission may have a definite and sound policy regarding the continuance of blister rust control in New York. In 1923, an extensive series of investigations were begun on these problems and some data is now available which we believe amply warrant the undertaking and which is now being prepared for publication. A brief summary of the more important results of these studies follows:

1. An examination of every white pine tree in fourteen one-acre plots, taken in natural stands of white pine in a north and south line extending from Lake George to the Canadian border shows that 50 per cent of the trees are infected and 39.8 per cent of them will be killed by blister rust within the next ten years.

2. Seventy-five per cent of all the white pine diseased with blister rust are in the more vigorous and thrifty class.

3. Where blister rust has been present ten years prior to the time of the studies there are comparatively few trees fifteen years old or younger. All facts to date show that blister rust is killing out the young reproduction of white pine almost as rapidly as it appears.

4. Blister rust spreads by waves of infection. There were large waves of infection on white pine in New York in 1911, 1913, 1916, 1919 and possibly in 1924. Each succeeding wave of infection was greater than the preceding one. The 1919 wave produced at least 65 per cent of all the infection found in a number of places.

5. There is a close relation between the spread of blister rust and weather conditions, especially moisture and temperature. This disease is now merely existing in some places, only to burst forth like a great explosion when favorable weather occurs. Blister rust has not run its course.

6. The crew method of controlling blister rust on a large scale is economically practical and is effective. Thirty-eight thousand seventy-three acres of white pine were protected in 1926.

7. The total average cost per acre for protecting white pine from blister rust in New York on privately owned land in 1925 was 88 cents.

8. The initial cost of protecting plantations of white pine from blister rust averages nearly 35 cents per acre. Protection from blister rust does not make the cost of establishing a plantation of white pine prohibitive.

9. Seedling currant and gooseberry bushes may spring up in a white pine woodlot following eradication. But average forest conditions are known to be extremely unfavorable to this development. The currant and gooseberry bushes found under most present forest conditions in New York as a rule start between the abandonment or clearing of the land and the complete establishment of the forest. Such bushes are almost invariably "left overs" from a previous type formation and undoubtedly obtained their development under relatively "open conditions."

10. Studies on numerous eradicated areas indicate that reeradication of the currant and gooseberry bushes by the crew method will rarely be necessary. In the majority of cases, the fence rows, stonepiles, breaks, swales and other likely places if such occur, should be scouted once about every five years to insure ample protection from blister rust over the period of rotation. This is work which one man can ordinarily do.

Pioneers in Systematic Control

In blister rust control work, we are doing what no nation has ever attempted, namely, the systematic and definite control of a forest tree disease. White pine blister rust is in America to stay. It is being economically and effectively controlled and the control and prevention of this disease is absolutely essential in any successful program of the management of white pine. It is incumbent upon American foresters, especially in the regions where white pine is grown as a timber crop, to have a clear understanding of the fundamentals of the biology of the fungus, Cronartium ribicola which causes blister rust, a keen appreciation of the subtlety of this disease, a readiness to act when control measures are necessary, and the right understanding of the proper application of control measures of this disease in relation to the silvics of white pine. While thousands of acres of white pine in New York are being annually protected from blister rust, white pine owners cannot realize the fullest benefits from blister rust control work until they are taught the simple principles of scientific woodlot management. In reality this is very inadequately done in New York today. Where does the burden of this responsibility rest?

THE ROLE OF FUNGI IN THE DISPOSAL OF SLASH

By Dr. Perley Spaulding

Pathologist assigned to the Northeastern Forest Experiment Station, Amherst, Mass.

FOR a proper orientation of the role of fungi as slash destroyers it may be well to consider briefly the major agents concerned in the disintegration of slash. There are three major agents or groups of agents which destroy all slash: fire, insects and fungi.

Fire Is Sanitary

Fire is far the best so far as forest sanitation is concerned. It has the very serious disadvantages of destruction of the advance reproduction, danger to surrounding forest, destruction of the duff which in some locations is all the soil there is available for trees to grow in, and high cost when properly controlled. Fire chars larger pieces of slash, so that fungi fruit upon them very sparingly. Fire promptly removes the larger part of the slash so that the ground is available for occupancy by new reproduction. This feature alone is worth considerable and I think has been overlooked to a great extent in estimating the real cost and value of different methods of handling slash. More will be said about this under the action of fungi. Where fire is properly controlled it usually is the preferable method of disposing of slash. The ideal method of using fire is to burn slash as made while cutting is going on. This can, as a rule, be done safely only under winter conditions.

Insects Intensive Workers

So far as personal experience goes, it appears that insects are quite transitory in their action upon slash. They work intensively in the inner bark and outer layers of wood for one year, or for two when the cutting is made at certain seasons. They bore holes in the wood indiscriminately, but the amount of slash which is actually destroyed is quite small. Their work in the bark results in the loosening and dropping off of the bark; this may not be an unmixed benefit, as it has seemed that unbarked slash commonly rots faster than that which has the bark removed promptly. Experience with log structures fully agrees with this idea also. This is certainly true of the top slash of soft woods which is largely rotted by *Lenzites sepiaria*. On the whole the action of insects in actual destruction of the slash is of minor

importance. Whether they have any influence in aiding fungi to get entrance is another question which we hope is in process of solution.

Fungi Have Tenacious Habits

The fungi at first merely discolor the wood. Fruiting bodies are formed by *Lenzites sepiaria* and *Polystictus abietinus* in softwood slash in the second season; in hardwood slash also the second season marks the first fruiting bodies of the wood attacking fungi. After this they increase in abundance for several years according to the surrounding conditions. When they have once begun to work they continue indefinitely until the slash is entirely destroyed. Their work is secured with no money outlay, although it may be found that certain methods of placing the slash when cutting it will favor their more rapid action. A slight cost in this way may be worth while in order to get maximum rapidity of destruction of the slash by them. In any event they will ultimately destroy the slash, whether we intentionally favor them or not.

A relatively small number of fungi accomplish most of the destruction. In dense piles of slash each fungus has its chosen place of abode, according to the conditions required by that fungus. Piling, scattering, lopping or not lopping tops, etc., etc. greatly influence conditions for the fungi. If a certain fungus is known to destroy most of the slash of a given species, and the optimum conditions for that fungus are known, the cutting of the slash so as to furnish those optimum conditions may result in hastening the rotting of the slash to a half of the time needed under adverse conditions. Each fungus attacks and consumes certain constituents of the wood. While two or more fungi may and often do attack the same piece of slash, each one works in a distinctly limited field. There is little or no overlapping even though one fungus takes only the lignin and another in the same piece takes only the cellulose. This is certainly true in the earlier stages of rot. Whether it is also true in the late stages is not known. There is a certain succession of the fungi as a rule; some attack early and soon finish their work, then others may appear upon the partly disintegrated wood. So far as our studies have gone it has been found that, as a rule, the fungi which attack slash are not those which are destructive to living trees. Like all rules this has its exceptions, but as a general thing it is true.

Completely rotted wood forms a thin layer of felted fibrous material on the top of the soil which persists for a long time and which interferes with reproduction of some of the most desirable species. This is especially marked with softwood slash and is one of the serious features of allowing slash to lie until automatically destroyed by the fungi. After the cutting of a dense stand the slash occupies a considerable proportion of the ground. Reproduction is delayed for years, certainly over 25 in some known cases. In deciding on methods of disposing of slash this matter should not be overlooked. While leaving the slash

to rot may seem to cost nothing it may really cost heavily in taxes on land which is but three-fourths or two-thirds fully stocked. If this were taken into account, it might prove cheaper to burn the slash.

Finally attention is called to the numerous factors involved in the rotting of slash: the numerous species of trees furnishing the slash, the abundant species of slash rotting fungi, the conditions under which slash is located, such as air and soil moisture, character of the soil, character of the climate, slope of the ground, etc., etc. Every one of these and others unmentioned have a potent influence upon the time taken to rot the slash. The matter is not a simple one and cannot be solved in a day because of this complexity. Anyone taking up work upon this problem should be careful to make his experiments simple. Do not try to get several different things from a single experiment or series of experiments, or the result when you are done will be a shotgun target of trifling results and minor reliability, instead of a rifle target of a single bullseye of maximum weight and clarity.

DECAY IN RELATION TO THE LENGTH OF ROTATION

By Dr. Henry Schmitz,

Dean of Forestry, University of Minnesota

THE question of the proper length of rotation in American forestry is still an open one. Even a cursory examination of the literature indicates that there is unanimity of opinion neither regarding the length of rotations or regarding the theories upon which rotations should be based. I take it for granted that it is not within the scope of the topic assigned me for discussion, namely, Decay in Relation to The Length of Rotation, to even touch upon the relative merits of technical, silvicultural, economic and financial rotations. Since decay, however, influences all of these methods of determining the proper cutting age, it may be necessary to refer to them from time to time.

The effect of decay on rotation is further complicated by the fact that the data available are both meagre and incomplete. For this reason, I wish to emphasize that what I have to say in connection is indicative rather than absolute, and it must not in any manner be regarded as the last word on this subject. I am certain that before I am through, you will all fully recognize and appreciate the full force of this statement.

I wish to emphasize further that the data upon which this discussion is based is in the main not the result of my own work, but rather on that of Meinecke, Boyce, Weir, and others. These investigators with the possible exception of Weir did not however correlate their data with rotation. If I have misinterpreted their data in this connection, I, not they, must be responsible for the errors involved. With this explanation fully understood, I will proceed.

Not a New Question

The question of the relation between decay and rotation is not entirely new, but it has been only within the last ten years that the subject has received any serious thought in American forestry. Credit for this progress is largely due to Dr. E. P. Meinecke, who in a splendid paper[1] clearly shows the importance of forest pathology in forest regulation. This publication is, I believe, worthy of careful study by all foresters interested in the management of forest properties.

Peculiarly enough, not even in Germany, where forest management is an established fact and where the diseases of forest trees have been studied for years, the relation between forest pathology and forest man-

[1] Meinecke, E. P. Forest Pathology and Forest Regulation. U. S. Dept. Agr., Bur. Plant Ind. Bul. 275, 1916.

agement has also been largely overlooked. Unfortunately there, as here, forest pathology has on the whole been regarded as something apart rather than part and parcel of forest management. Notwithstanding this general condition, however, Möller[2] pointed out the way in which pathological data might be of valuable assistance to the practicing forester in helping him to determine the proper answer to the complicated question of rotation. Möller in connection with a study on heart rot in pine, states, "Whilst the mean annual increment of the stand is slowly decreasing, the mean annual increment of decay is steadily on the increase." It is perfectly obvious that the length of any rotation, no matter what the basis for its choice may be, would of necessity be shorter than the age at which the mean annual increment of decay is greater than the mean annual increment of the tree. It is my personal opinion, on account of the many variable factors involved, that we will never be able to determine this point to the exact year. Certainly none of the available data would permit of its determination to a single year. We will for the time being at least have to content ourselves with determining it approximately, say within ten or twenty year periods.

In scanning the literature on this general subject, it is not uncommon to note that maximum rotations in which decay is the limiting factor are sometimes mentioned. That is to say, even without any definite data on the subject, it is apparent that after a certain number of years decay causes so great a loss that it is impractical to extend the rotation beyond that time. For example, Grennamyre[3] mentions that on the Apache National Forest the decay in Douglas fir "no doubt largely offsets the growth after the age of 210 years is reached." Munger,[4] discussing the management of Douglas fir in the Pacific Northwest, claims there is very little decay until an age of 150 years is reached, but that in mature and overmature timber there is a great deal of defect due to decay. Long,[5] working on the decay in western yellow pine, found "that during the blackjack period (up to 180 years) the trees are practically free from this rot (western red rot), while trees over 200 years old show a much higher percentage of rot than younger trees. It is a fundamental fact that the older the tree is the more liable it is to be attacked by heart rot fungi." It is interesting to note in passing that Woolsey [6] tentatively recommends a rotation of 200 years for western yellow pine.

Other examples might be given, but these will suffice to show that generalities relative to the critical age of certain trees are common.

[2] Möller, A. Uber die Notwendigkeit Wirksamer Bekampfung des Kieferbaumschwammas Trametes Pine Thore Friesztchr. Forst-u. Jagdw. 36: 1904. 677–715.

[3] Grennamyre, H. H. The Composite type on the Apache Nat. Forest. U. S. Dept. Agr., Forest Service. Bul. 125. 32 p., 4 figs. 1913.

[4] Munger, T. T. The growth and management of Douglas fir in the Pacific Northwest. U. S. Dept. Agr., Forest Ser. Circular 175. 27 pp., 4 figs. 1911.

[5] Long, W. H. A preliminary report on the occurrence of Western red rot in Pinus ponderosa. U. S. Dept. Agr., Bur. Plant Ind., Bul. 490. 1917.

[6] Woolsey, T. S., Jr. Western yellow pine in Arizona and New Mexico. U. S. Dept. Agr., Forest Ser. Bul. 101. 1910.

Specific Data Given

It is now my intention to submit to you for your consideration some of the more carefully collected decay data, revamped to a considerable extent to show how far it may be used to indicate the relation between decay and rotation. In revamping this material, it has been necessary to take many liberties with the original data, and I wish to again emphasize that the original author should not be held responsible for my interpretations or misinterpretations if there be any.

Douglas Fir

The decay of Douglas fir is of outstanding interest on account of the great commercial importance of the tree, the general prevalence of disease, and on account of the enormous amount of cull in the virgin stands of the West. In a preliminary study of the decay in Douglas fir, Boyce[7] presents the following data:

TABLE I — DECAY OF DOUGLAS FIR. DATA FROM BOYCE (1163)

AGE CLASS	Average age	Average diameter	Cull percentage of total volume
41– 60	59	9.5	.04
61– 80	68	12.1	.91
81–100	95	14.0	.53
101–120	103	16.3	.75
121–140	129	16.0	.15
141–160	....	....	....
161–180	....	....	....
181–200	193	18.7	1.36
201–220	214	25.3	15.49
221–240	230	27.5	32.69
241–260	246	27.9	10.81
261–280	271	28.1	15.81
281–300	284	29.2	1.52
301–320	309	29.7	6.07
321–340	333	29.8	10.38
341–360	348	28.9	2.48
361–380	362	39.6	1.00

Unfortunately Boyce does not give the total volume of the tree studied, and for our purpose it is necessary to have this information. This data was obtained by plotting diameters on age as given by Boyce (Fig. 1) and reading the diameters from the curve. The volume of trees of these diameters was then obtained from Volume Table 59, "Volume Tables of the Important Timber Trees of the United States, Part I."

In order to smooth off the results, Boyce's data on cull per cent were also plotted, cull per cent on age and a curve drawn (Fig. 2). This curve is interesting in that it shows a decrease in cull per cent

[7] Boyce, J. S. The study of decay in Douglas fir in the Pacific Northwest, U. S. Dept. Agr., Bur. Plant Ind. Bul. 1163. 1923.

of individual after an age of approximately 230 years is reached. This is, of course, impossible and is evidence of the fact that new factors have been introduced after that age has been reached. Undoubtedly the stand breaks up at about this age and only the more disease free trees remained standing. The cull data beyond 250 years was consequently not used.

From Figs. 1 and 2 and Volume Table 59, the following data were then obtained:

TABLE II — DECAY OF DOUGLAS FIR

(DATA FROM CURVES)

AGE	Diameter	Volume	Per cent decay	Volume decay	Periodic growth	Cull increment
Average of age class	(From curve)	Cu. ft. volume table 59	(Curve figure 2)	Cu. ft. columns 3 and 4	Cu. ft. 20 year period	Cu. ft. 20 year period
50	9	13.6	.5	.06	....	....
70	12	27.6	.6	.16	14.	.10
90	15	51.8	.7	.36	23.2	.20
110	17	67.4	.7	.47	16.6	.11
130	19	99	.8	.79	31.6	.32
150	21	122	.8	.97	23	.18
170	23	150	2.0	3.0	28	2.03
190	25	176	5.6	9.8	26	6.8
210	27	215	13.2	28.4	39	18.6
230	28	228	23.0	52.4	13	24
250	29	259	32.0	82.8	31	30

In Fig. 3, the periodic growth and the increment of decay in Douglas fir are compared graphically. It is evident that the loss from decay is practically negligible until an age of approximately 160 years is reached. After that age is reached, it increases rapidly. At 250 years, the periodic growth and cull increment are approximately equal. This age, then namely, approximately 250 years, would be the limit of any rotation for Douglas fir irrespective of the basis of choice, since beyond this age the net merchantable volume of the tree decreases. Obviously also rotations less than 160 years would be influenced little by loss from decay. In other words, if Douglas fir is grown on a rotation of 160 years or less decay can practically be eliminated from the picture.

Incense Cedar

Boyce has also made a pathological study of incense cedar,[8] an unusually defective species. As a matter of fact, this tree is often considered a weed tree, or an inferior species, not on account of the inherent properties of the wood but rather on account of the enormous amount of cull ordinarily present.

Fig. 4, showing the relation between age and volume of incense cedar, is taken directly from Boyce's data (Fig. 1, p. 26). I have, however, averaged the two curves indicating growth on optimum and inter-

mediate areas, and have used the average figures in this discussion. Fig. 5, showing the relation between age and rot is also taken directly from Boyce's paper (Fig. 3, p. 48). From these two curves the following data was obtained.

TABLE III — DECAY OF INCENSE CEDAR

(DATA FROM CURVES)

AGE	Volume, cu. ft.	Per-centage cull	Volume cull, cu. ft.	Periodic growth, cu. ft. 20 year period	Cull increment, cu. ft. 20 year period
20	22	0	0	....	....
40	40	0	0	18	0
60	60	0	0	20	0
80	80	.5	.4	20	.4
100	96	1	.96	16	.56
120	114	2	2.3	18	1.34
140	132	4	5.3	18	3.0
160	148	8	11.8	16	6.5
180	160	12	19.2	12	7.4
200	172	18	30.9	12	11.7
220	180	26	42.8	8	11.9
240	188	36	67.7	8	14.9
260	196	45	88.2	8	20.5
280	202	54	109.0	6	20.8
300	208	61	126.9	6	17.9
320	212	68	144.2	4	17.3

In Fig. 6 is shown the relation between the periodic growth and the cull increment of incense cedar. It is apparent that the pediodic growth of incense cedar is high in the early life of the tree, but that it falls steadily and fairly rapidly after an age of 120 years is reached. The cull increment, on the other hand, is almost negligible up to 120 years, but increases rapidly and exceeding periodic growth at about 210 years. Here again approximately 210 years would limit any rotation for incense cedar, but rotations less than 120 years would be influenced little by decay.

Western Hemlock

Let us turn our attention to western hemlock. This tree in the virgin stands of the West is ordinarily very defective and the wood of the species is usually considered to lack any marked degree of durability. Weir[9] and Hubert, in one of the earliest pathological studies made in this country, collected considerable data on heart rot of the western hemlock in the Inland Empire. These data do not, however necessarily hold for the Coast region, where hemlock is found in greatest abundance. These investigators recognize two general types

[8] Boyce, J. S. Dry Rot of Incense Cedar. U. S. Dept. Agr., Bur. Plant Ind. Bul. 871. 1920.

[9] Weir, J. R. and E. E. Hubert. A study of the Heart Rot in Western Hemlock. U. S. Dept. Agr., Bur. Plant Ind. Bul. 722. 1918.

in their study, namely: the slope type and the river bottom type. I have arbitrarily selected the data presented for the slope type in this discussion.

Weir and Hubert do not include any data on diameter and volume in their paper, and I have therefore found it necessary to use the data given by Allen[10] on diameter growth, even though the data was not collected in the same region as the pathological data.

Fig. 7 represents a curve showing the relation of age to diameter, and is taken directly from Allen's data. The curve is, however, extended beyond 120 years, since this is the maximum age dealt with in Allen's paper. It will be noted that the curve flattens out very markedly beyond 160 years. This slow growth makes it impossible to determine with any degree of accuracy the volume of the trees at the even decades, since it requires over ten years to increase one inch in diameter. By plotting the volume by the different age classes, Fig. 8, a curve was obtained from which volumes for the even decades might be obtained.

Fig. 9 is the curve resulting when Weir and Hubert's pathological data are plotted and rounded off. The volumes of rot in western hemlock in the different age classes were taken from this curve in this discussion. From Figs. 7, 8, and 9 the following data suitable to show the relation between age and cull were obtained.

TABLE IV — CULL DATA FOR WESTERN HEMLOCK

AGE	Diameter	Volume table 62 basis of Figure 8	Volume from curve, Figure 8	Volume of rot, Figure 9	Periodic cull, 10-year period	Increment growth, 10-year period
30	6	11.4	15	0	....	....
40	8	17.9	18	0	3	0
50	10	26.2	22	0	4	0
60	11	30.	27	0	5	0
70	12	34.3	34	.25	7	.25
80	13	41.6	41	.50	7	.25
90	14	50.0	50	2.	9	1.5
100	15	60.5	58	4.0	8	2.0
110	....	....	66	6.0	8	2.0
120	16	76.5	75	9.0	9	3.0
130	....	....	83	12.0	8	3.0
140	17	90	90	15.0	8	3.0
150	....	....	96	19.0	6	4.0
160	18	110.	102	22.0	6	3.0
170	....	....	108	26.0	6	4.0
180	18	110	112	30.0	4	4.0
190	....	....	117	35.0	5	5.0
200	....	....	121	40.0	4	5.0
210	....	....	125	46.0	4	6.0
220	....	....	129	52.0	4	6.0

In Fig. 10 the periodic growth and cull increment for western hemlock is compared. It is evident that western hemlock makes fairly rapid growth up to an age of almost 120 years, after which the incre-

[10] Allen, E. T. The Western Hemlock. U. S. Dept. Agr., Bur. Forest Service. Bul. 33. 1902.

ment drops off. Decay, on the other hand, is negligible up to about 90 years, but then increases rapidly. Even at 100 years about one-fourth of the periodic growth for a ten-year period is offset by decay. It is not at all unlikely, if rotations of one hundred years are used for western hemlock, that decay may be an important factor in limiting the exact length of the rotation. In rotations shorter than 90 years, decay apparently will not be an important factor.

Western White Pine

Weir and Hubert[11] have also made a study of the heart rots of western white pine in the inland Empire. Western white pine, as you no doubt know, is the key tree to forestry in that particular region, and for that reason the question of cull in the species is one of primary importance. In this study of the rots of western white pine, Weir and Hubert recognized two general sites, bottom sites and slope sites, and in this case I have re-worked the data pertaining to both sites to show the influence of site on the amount of cull. These investigators obtained the following data, showing the relation of rot to age classes in western white pine on sites of the bottom and slope types.

TABLE V — RELATION OF ROT TO AGE CLASSES IN WESTERN WHITE PINE ON SITES OF THE BOTTOM AND SLOPE TYPES

(DATA FROM WEIR AND HUBERT)

AGE CLASSES	Average age	Total volume, cu. ft.	Total rot, cu. ft.
Bottom Sites:			
40– 60	52	0.99	0
61– 80	73	30.7	.8
81–100	88	82.7	1.7
101–120	113	150.9	4.2
121–160	131	196.2	9.5
161–200	180	203.0	19.0
201–	289	450.5	3.0
Slopes Sites:			
41– 60	48	2.7	0
61– 80	65	4.6	.03
81–100	91	11.2	.19
101–120	110	57.9	.8
121–160	137	178.9	5.7
161–200	164	237.3	7.3
200 years	343	485.2	76.3

In Fig. 10, I have plotted total rot on age as given above for both site classes, and in Fig. II, I have plotted total volume on age for both site classes. From these curves, it is possible to obtain both total volume and volume of total rot for the even year age classes. These data for the bottom site are presented in Table VI, while the data for the slope type is presented in Table VII. The periodic growth and the cull increment has also been calculated for each age class.

[11] Weir, J. R. and E. E. Hubert. A study of the rots of Western white pine. U. S. Dept. Agr., Bur. Plant Ind. Bul. 799. 1919.

TABLE VI — RELATION OF ROT TO AGE CLASSES IN WESTERN WHITE PINE ON SITE OF THE BOTTOM TYPE

(DATA FROM FIGURE 10 AND FIGURE 11)

AGE	Volume, cu. ft., Figure 11	Volume rot cu. ft., Figure 10	Periodic growth cu. ft., 10-year period	Cull increment, cu. ft., 10-year period
40	3	0	....	....
50	12	0	9	0
60	23	0	11	0
70	34	0	11	0
80	46	.5	12	.5
90	60	1.0	14	.5
100	73	2.0	13	1.0
110	90	3.5	17	1.5
120	108	5.0	18	1.5
130	128	7.0	20	2.0
140	150	9.0	22	2.0
150	174	12.5	24	3.5
160	201	14.5	26	2.0
170	224	18.0	23	3.5
180	243	21.0	19	3.0
190	260	25.0	17	4.0
200	276	29.5	16	4.5
210	293	34.0	17	4.5
220	306	38.0	13	4.0
230	319	43.0	13	5.0
240	332	48.0	13	5.0
250	344	54.0	12	6.0

TABLE VII — RELATION OF ROT TO AGE CLASSES IN WESTERN WHITE PINE ON SITES OF THE SLOPE TYPE

(DATA FROM FIGURE 10 AND FIGURE 11)

AGE	Volume cu. ft., Figure 11	Volume rot, cu. ft. Figure 10	Periodic growth, cu. ft. 10-year period	Cull incremet, cu. ft. 10-year period
40	2	0	....	....
50	3	0	1	0
60	4	0	1	0
70	8	0	4	0
80	16	0	8	0
90	24	0	8	0
100	36	.5	12	5
110	53	1	17	5
120	80	2.5	27	1.5
130	122	4	42	1.5
140	154	5	32	1.0
150	180	7	34	2.0
160	204	9	24	2.0
170	228	11	24	2.0
180	248	13.5	20	2.5
190	264	16	16	2.5
200	281	19	17	3.0
210	298	22	17	3.0
220	309	25	11	3.0
230	321	28	12	3.0
240	332	32	11	4.0
250	342	36	10	4.0

In Fig. 12 (a) the periodic growth and the cull increment for white pine on bottom sites is compared. This graph indicates that in white pine cull increment is comparatively small when compared to the periodic growth until an age of 160 years is reached. Even at 250 years the cull increment is only 50 per cent of the periodic growth.

Fig. 12 (b) gives the same information for the slope type that Fig. 12a gives for the bottom type. What has been said for bottom types holds fairly true for the slope type, except that in the latter case the amount of cull is less.

These two figures are interesting, inasmuch as they indicate that site plays an important part in the development of rot in a stand. In this particular case, the total amount of cull in the bottom site is considerably higher than that in the slope types.

The work of Mason* indicates that a relation of 100 to 120 years for western white pine gives a maximum yield. At this age the per cent is comparatively small.

Aspen

Very little pathological data is available which deals with cull in hardwoods. The only material suitable for our purpose is found in an unpublished manuscript by Meinecke[12] dealing with the decay of aspen in Utah. This study covered a comparatively small area only, and for that reason the results can not be considered to necessarily hold for the species even in the West.

Aspen makes an unusually interesting species for pathological study on account of its wide distribution and on account of the general prevalence of decay in the species. A little later I will present the results of our work on aspen in Minnesota for comparison.

Meinecke (Table 1) gives the following basic data in connection with his study of heart rot in aspen.

TABLE IX—RELATION OF ROT TO AGE IN ASPEN

(FROM TABLE I — MEINECKE)

AGE CLASS	Total Merch. volume, cu. ft.	Rot, cu. ft.
30– 40	10.32	14.
41– 50	12.82	....
51– 60	52.78	2.47
61– 70	56.05	2.11
71– 80	65.13	3.65
81– 90	173.79	5.23
91–100	118.89	13.64
101–110	116.11	21.01
111–120	214.03	56.68
121–130	176.89	73.46
131–140	88.04	9.07
141–168	172.45	38.89

* Mason, D. T. Management of Western White pine. Proc. Soc. Am. Foresters, 9, p. 61. 1914.

[12] Meinecke, E. P. Pathology of quaking aspen in relation to the management of the species in Dist. four—unpublished manuscripts.

In Fig. 13, the data, both for cull and total merchantable volume is plotted on age. It is interesting to note that in the cull curve the amount of cull in the 131-140, and 141-168 year age classes is very low. As I have said before in connection with the Douglas fir data, the amount of cull can not very well decrease with an increase in age unless other factors are introduced. I have, therefore, disregarded these points in extending the curve beyond the 121-130 year age class. From the two curves presented in Fig. 13, the following volume and cull data was obtained.

TABLE IX — RELATION OF ROT TO AGE IN ASPEN

(DATA FROM FIGURE 13)

AGE	Merch. volume cu. ft.	Cull volume cu. ft.	Periodic growth cu. ft. 10-year period	Cull increment, cu. ft. 10-year period
30– 40	10	0	....	....
41– 50	20	0	10	0
51– 60	34	1.0	14	1.0
61– 70	53	2.0	19	1.0
71– 80	76	3.5	23	1.5
81– 90	101	5.0	25	1.5
91–100	124	16.0	23	11.0
101–110	140	30.0	16	14.0
111–120	153	56.0	13	26.0
121–130	163	73.0	10	17.0
131–140	172	90.	9	17.0
141–168	178	101.	6	11.

In Fig. 14, the periodic growth of aspen and the cull increment for ten-year periods are compared.

It is apparent that in Utah aspen grows quite rapidly up to an age approximately 85 years, after which the periodic growth decreases quite rapidly. Up to this age, cull from decay is very small, but after 85 years it increases with astounding rapidity. At about 110 years, the increment of decay exceeds periodic growth. At approximately 115 years, the increment of decay is almost twice the periodic growth.

Last summer, the Division of Forestry, University of Minnesota, undertook a pathological study of aspen in Minnesota. In this study three different stages of decay were recognized: incipient, intermediate, and final. Incipient decay refers to wood faintly colored from light pink to straw brown. The intermediate stage includes all degrees of coloration from straw brown to chocolate brown, but in which the wood is still hard and firm. The final stage refers to soft, punky wood, irrespective of the color.

These three stages of decay were recognized in order to permit the determination of cull for certain industries utilizing aspen. For example, the excelsior industry apparently accepts all sound firm wood irrespective of color; the pulp industry accepts, as far as I have been

able to determine, dark colored wood, provided the specific gravity has not been materially reduced. The industry culls the darker discolorations even though the wood may be quite firm. Certain box specifications call for "white sound" wood. In this case, even the incipient stage may be considered cull. We have not yet definitely correlated these stages of decay with utilization in any of the industries. These remarks are therefore only indicative.

The field data was worked up on both the basis of total and merchantable volume, but for this discussion I am using only that based on total volume. This data, based on 640 trees, is presented in Table X.

In Fig. 15, the average tree column is plotted on average age of each age class. The curves represents the average volume in cubic feet at different ages. In Fig. 16, the percentages of total rot on age are plotted and curved, resulting in Graph A. These smoothed percentages were applied to the smoothed valued of the volume of the trees for the different age classes. The smoothed values for total rot on age are given in Column 4, Table XI. In Table XI, are also shown the periodic growth of aspen for ten year periods and the increment of total decay. It will be noted that the period of maximum production of net wood occurs at 60 years.

Since the volumes of the three stages of rot as determined from the original data require smoothing and at the same time require that the smoothing shall be accomplished without interfering with the relationship between the various stages of decay, the original data was graphically correlated in the following manner. The original data for intermediate and final rot was plotted on the smoothed valued for total rot. The resulting curve is a graphical correlation between total rot and intermediate, plus final rot. Graph B, Fig. 16 represents the curve resulting from this procedure.

The relationship between final rot and total rot was obtained in a similar manner, resulting in Graph C, Fig. 16.

From Fig. 16, Fig. 17 was prepared which shows the variation of each stage of rot with age, and also the relative or per cent value of each stage as of the total rot (100%) at the particular age class. This figure shows in graphic form how each stage of the rot, as per cent of total rot, varies with age and what the most probable proportion of each stage of rot at any particular age will be.

From Fig. 16, Graph A, representing the smoothed value for the per cent of incipient rot, Graph B, representing smoothed values for the per cent of intermediate rot, and Graph C, representing smoothed values for the per cent of final rot, Table XI was prepared. This table gives the amount in cubic feet for the various stages of rot and also the increment of rot for each stage of ten-year periods.

These values for intermediate plus final rot are graphically represented in Fig. 18.

TABLE X — RELATION OF ROT TO AGE IN ASPEN IN MINNESOTA

(ORIGINAL DATA OF SCHMITZ AND JACKSON BASED ON TOTAL TREE VOLUME)

Age Class	Average age	Basis No. 1 trees	Average volume per tree	Rot					
				Total rot		Intermediate and final		Final	
				Volume, cu. ft.	Per cent of total tree volume	Volume, cu. ft.	Per cent of total tree volume	Volume, cu. ft.	Per cent of total tree volume
11– 20	16	28	1.53	.78	5.1	.007	.46	00.00	00.
21– 30	26	99	2.27	.233	10.3	.082	3.6	.024	1.1
31– 40	37	146	4.75	.723	15.2	.259	5.4	.045	0.9
41– 50	44	144	7.54	1.43	19.0	.711	9.5	.174	2.3
51– 60	51	115	11.37	2.712	23.8	1.275	11.2	.319	2.8
61– 70	63	86	18.52	4.808	25.9	2.744	14.8	.952	5.1
71– 80	75	9	36.52	12.777	35.0	9.611	26.3	5.477	15.0
81– 90	87	5	44.30	10.240	23.1	4.700	10.6	3.650	8.3
91–100	96	4	23.50	10.800	46.0	10.675	45.2	5.075	21.6
101–110	102	4	29.82	11.125	37.4	10.625	35.5	7.050	23.6

Table XI — Relation of Rot to Age in Aspen in Minnesota
(Data from Curves. Figures 15, 16 and 17)
Based on Total Tree Volume

Age	Total volume	Per cent of total rot	Volume total rot cu. ft.	Volume incipient rot cu. ft.	Volume intermediate rot cu. ft.	Volume final rot cu. ft.	Periodic growth cu. ft. 10-year period	Cull increment total rot cu. ft. 10-year period	Cull increment intermediate and final cu. ft.
10	.8	3.0	.02	.017	.003	....	....	....	....
20	1.6	7.5	.12	.090	.030	....	.8	.1	.27
30	3.0	12.0	.36	.240	.115	.005	1.4	.2	.093
40	5.9	17.0	1.00	.570	.370	.060	2.9	.6	.310
50	10.6	21.8	2.31	1.12	.91	.28	4.7	1.3	.76
60	16.5	26.2	4.32	1.74	1.73	.85	5.9	2.0*	1.39*
70	23.0	30.5	7.01	2.94	2.88	1.88	6.5	2.7	2.18
80	30.0	34.3	10.30	2.60	4.15	3.55	7.0	3.3	2.94
90	36.0	37.7	13.60	2.58	5.25	5.77	6.0	3.3	3.32
100	39.2	40.5	15.90	2.20	5.55	8.15	3.2	2.3	2.68
110	40.2	43.0	17.30	1.62	5.18	10.50	1.0	1.4	1.98

* Rotation or period of maximum production of net wood.

Note that if incipient rot is excluded the period of maximum production of net wood is also at 60 years.

Considering rotation from a pathological point of view, the rotation for aspen in the Lake States will probably be from 60 to 70 years. Growth and yield studies for this species in the Lake States also indicates this to be the probable rotation from a yield point of view.

The length of rotation for aspen will probably vary in different parts of the country, depending upon the purpose for which the material is to be utilized. In all probability one of the main uses for aspen in the future will be for paper manufacture, and for this purpose the rotation will undoubtedly be short. Should a match industry utilizing aspen develop in America, it may well be that even incipient decay will be culled. Even in these cases, decay may be the controlling factor in determining the length of rotation. For example, Weigle and Frothingham[13] state, "For Aspen in the Northeast, the maximum age which the trees may be allowed to attain is fixed by the relatively early beginning of decay at approximately 80 years. In fully stocked, healthy stands in the best sites, this is the age at which dominant trees reach their maximum yield. Since, however, decay frequently sets in much earlier, necessitating the immediate removal of the trees while yet considerably under full size, the length of each rotation can not be made arbitrary, but must depend upon the condition of the stand." This statement is significant, since it emphasizes certain limitations to general pathological studies. The amount of cull varies, not only with age and site but also with the degree with which the stand is stocked. It may indeed even vary with the associated species.

With one possible exception, we have now covered most of the decay data dealing with American forest trees. Meinecke's[14] work on white fir would, I am sure, be of great interest, but data as presented does not lend itself to our purpose. In the West, white fir is an unusually defective tree and in all probability it would serve as another example to show that heart rot may be the controlling factor in determining length of rotation in certain species.

We now come to the crux of this discussion. Do, or will, pathological studies solve the complicated and much mooted question of rotation? Before this query is answered, we should consider several contributing factors not yet discussed. All of the studies referred to in this discussion, with the possible exception of aspen in Minnesota, were made in natural virgin stands. Even in the latter case these aspen stands were wild and unmanaged. The results are therefore applicable only to such stands and there is no evidence whatsoever that they will necessarily hold for future stands handled under more or less intensive forest management. As a matter of fact, there is

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[13] Weigle, W. G., and E. H. Frothingham. The Aspens: Their Growth and Management. U. S. Dept. Agr., Forest Service. Bul. 93. 1911.

[14] Meinecke, E. P. Forest pathology in forest rebulation. U. S. Dept. Agr., Bu. Plant Ind. Bul. 275, 1916.

every reason to believe that managed forests will suffer materially less from decay than do virgin stands.

The relation between wounds and decay becomes immediately apparent to anyone working in the field of forest pathology. In unmanaged forests, one of the most prolific sources of wounds is fire. For example, Meinecke[15] found that "fire wounds offer the most common way of entrance" in decay of white fir. Boyce[16] states that "The most serious wounds, both numerically and in regard to the type of injury, result from fire." With better fire protection, the number of fire scars will be materially reduced, and with a reduction in fire scars the amount of cull from decay will likewise be reduced.

In the managed forest, also diseased and unhealthy trees will be removed early in the rotation as thinnings, thus leaving only comparatively healthy trees in the final stand. Forest management will also result in better pruning of the stand, and will in this way reduce the possibility of infection through large exposed branch stubs. In short, forest management will go a long way towards reducing losses from decay. Let me emphasize, however, that forest management will not entirely eliminate these losses, since German experience clearly indicates that, even with their intensive forest management, losses from decay are important and material.

Then, too, I sometimes feel that our approach to pathological studies has been wrong to some extent at least. Have we not put the emphasis on individual trees instead of on stands? Would our data not be far more significant if we had approached the problem from an area basis rather than from the basis of the individual tree? I am forced to the conclusion that it would have been far better had we adopted the former basis.

Let me illustrate by a specific example. In connection with our work on aspen in Minnesota, we studied a sample plot having a few scattered trees about 75 years of age. These trees were quite defective and having an average cull (intermediate and final stages of decay) of 9.6 cubic feet, or 26.3 per cent of the volume of the tree. These few 25 year old trees did not, however, represent the important constituent of the stand in question, since the main part of the stand in that area was represented by a 45 year age class.

In other words, in old decadent stands younger trees of the same, or different species, are constantly coming in and the per cent cull on an area basis would be quite low.

I fully recognize the fact that many species of trees reach an age far in excess of 75 years, but I believe that there is a certain critical age at which the stands of any species break up. At this age, new trees are coming in in considerable numbers, and even though the pathological data for the old age class may actually show that the

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[15] Meinecke, E. P. Forest pathology in forest regulation. *loc. cit.*
[16] Boyce, J. S. Dry rot of incense cedar. *loc. cit.*

increment of decay equals or surpasses the increment of growth, we might get an entirely different picture if our data had been collected on an area basis. I would indeed very much like to see such a study made.

In short, we have not solved the question of rotation by pathological studies. We have, however, determined the physical or silvicultural rotation of the trees studied when growing in unmanaged stands.

These studies also indicate in a general way the maximum length of rotation, but do not specifically determine most advantageous rotation.

Practically all foresters are, I believe, of the opinion that rotations will become shorter rather than longer, and if this is the case, they may well be within the limits of the critical age of the particular species concerned.

Furthermore, I fully agree with Boilley[17] who cautions against placing too much stress on age in considering rotation.

Quoting this author "———— they persist in confusing the age and the size of the trees. The age or time is only one of the factors of the result sought for (and not the principal one). The result sought for can only be *production*. The age is only an accessory." If the trend in American forest regulation is toward a technical rotation, modified to some extent by financial considerations then the rotations of the future will probably be no longer than is necessary to grow material for certain specific uses. If material can be grown to the desired size in lengths of time less than the age at which considerable losses from cull occur, then decay will not be the limiting factor in determining the length of rotation.

In spite of what I have just said, however, I feel most emphatically that there is the greatest need for both more and better pathological data concerning American forest trees in both virgin and managed stands. Our virgin forests are far from gone, and I personally feel that we will still have some virgin timber, particularly on the National Forests, for the next 100 years. What will happen to this timber during these years, only pathological studies can tell. Pathological studies should, I believe, be that basis for the selection of many sale areas on the National Forests, since virgin timber in many localities is rapidly becoming more and more defective. Sometimes I am almost forced to the conclusion, considering the serious economic condition in which the entire lumber industry now finds itself, that at present the only justification for any sale of National Forest timber is its pathological condition.

Another important reason for having more pathological data is to make much of the work on growth and yield really significant. Most growth and yield studies entirely ignore the question of decay. Foresters, lumbermen and loggers alike are not interested alone in the

[17] Boilley, H. E. L'Amenagement des Forets par la Methods Experiimentale at Specealement La Methods du Controle. Paris 1920. (Reference in American Forest Regulation by Woolsey, T. S., Jr.)

gross dimensions of trees, but rather in merchantable volume. Foresters are not primarily interested in increment, but in net merchantable increment. The ultimate expression of growth and yield must be in terms of merchantable volume, if many of these studies are to serve the purpose for which they are intended. Investigators along this particular line of forest mensuration would do well to acquaint themselves more thoroughly with the facts already brought to light by forest pathologists, and more important still, foresters responsible for the administration and management of both public and private forest properties should put into effect those practices consistent both with good forest management on the one hand and with good forest protection on the other whenever and wherever possible.

Forest pathologists are indeed rendering a distinct service to forestry in America. It only remains for the results of their work to be put into effect by foresters.

THE WHITE PINE WEEVIL PROBLEM IN THE NEW ENGLAND STATES

By Harvey J. MacAloney,

Assistant Entomologist, Northeastern Forest Experiment Station, Amherst, Mass.

THE white pine weevil is the most serious insect pest affecting this species and indeed in some localities it is the most serious of all pests. This weevil is a native insect, and was first described by Peck in 1817. Since then it has been studied by several entomologists all of whom have contributed valuable information. It has always been of importance throughout the range of the white pine. However, I believe that the amount of injury has increased greatly in the last seventy years. Especially is this so in the New England States. About 1850 the farms began to be abandoned, and this reached the peak in the period between the end of the Civil War and 1880.

Many of the fields reverted to the forest types, and many of them were seeded in by white pine. The typical old field stand resulted. These stands are now in the main poorly stocked and have been weeviled repeatedly. Forty or fifty weevilings in a single tree are by no means rare. One which was climbed this summer and measured at all weeviled points was 60 years old, 66 feet tall, and had been weeviled 67 times. Another, a slide of which will be shown on the screen shortly, is about 30 feet high, and has been weeviled about 40 times, with the most of these weevilings between 10 and 25 feet. It is a typical cabbage pine. Add to this acreage of old field pine, the great acreage of plantations set out within the past thirty years. All this gave abundant food for the weevil, and this probably has been the cause for the very rapid increase in infestation during the past 50 years. We now have one of the most important forest insect pests in the Northeast.

The range of the white pine weevil is very similar to the range of the white pine itself, but is not so important in the westerly or southerly portions as it is in the northeastern and Lake States.

The Weevil Described

The white pine weevil is a small snout beetle, about ¼ inch in length. It is light to dark brown in color, mottled with lighter scales over its wingcovers. The larvae, which do the damage, are white footless grubs, and when fully grown are slightly larger than the adult. About two and one-half to three months are required for

Photo P. R. Gast

a. Typical "Cabbage" Pine about 30 feet high. Weeviled 40 times between 10-25 feet.

development from the egg stage until the emergence of the adult. Emergence continues until late September or early October, but the most of the emergence takes place in August. The adults feed until excessive cold weather sets in and then they go into hibernation in the duff and litter. They come out of hibernation the following spring, about the time the buds begin to swell, this time depending on the climate and temperature. The first few days are spent feeding, mostly on the buds and extreme tip of the leader, and then mating takes place. After this the females begin to lay eggs, depositing from 50 to 150 eggs, probably in several leaders. A large number of leaders have been examined and the number of eggs laid in a single leader may vary from 20 to 350, with an average of about 125, and an average of 170 punctures. Roughly therefore 75 per cent of the

punctures contained eggs. It should be mentioned here that these leaders were taken from a heavily infested plantation with a sunny exposure. Leaders from more lightly infested plantations might not show so great a number of eggs. The females lay eggs from about the first of May until the end of July. Sometimes the beginning is later, as this year for example, with a corresponding lateness in the summer for the final time. This year the final egg laying was observed on August 2. Locality has a great deal to do with the period of egg laying. In Connecticut at the Rainbow Plantations this year the first weevils were seen on April 23. Seventy miles north they were not observed until May 3. The peak of the egg laying is reached about three weeks after the beginning, with a gradual falling off until by the first of July it will normally have practically ceased.

The eggs hatch in from 6 to 14 days, depending again on the weather. Immediately after hatching the larvae begin to feed on the tender inner bark, and as they grow older, between the bark and the wood. A large number of larvae will destroy the living tissue in a short time, and the growth of the present year may be very small. This is not always the case for when leaders are weeviled later in the season, practically the whole year's growth may have taken place. There are then, in a current season, all gradations between no height growth and practically all of it. This is an important consideration in one phase of direct control, that of removal of leaders which will be taken up later. The larvae follow down the stem side by side, as many as 150 being packed in closely in two inches of the stem. As a larva, which is a little older than the other, attains full size, it drops behind, bores into the pith and pupates. As will be shown later these are the only ones, in many cases, which eventually emerge. The actual number which emerge is but a very small percentage of the eggs laid. This is due to many things, such as parasites, predatory insects and birds. Many also probably die from lack of food, or from smothering in the resin.

How Weevils Operate

The manner in which the weevils reach the leaders has for some time been a matter of argument. It appears that they may get there by one of several ways, but the probability is that they fly to the tree itself, striking perhaps the leader, but more often the branches, and then crawling up the stem until the leader is reached. Evidence also shows that they may crawl up from the bottom of the tree. An experiment which has been tried before was tried last spring to determine the exact way. Bands of tanglefoot were placed on the trees at different places before any weevils had come out of hibernation. Two plots of one-tenth of an acre each were laid out, with check plots to the north, south, east and west. In one of the plots all the trees were banded at the top, just above the last year's growth of laterals, with the trees on the border banded at the base. This was to prevent the

weevils from coming in from the outside plots except by flight. The other treated plot had the trees on the outside banded at the bottom and the top, with the trees on the inside banded at the bottom only. In both cases the banded plots showed a substantial decrease in per cent of weeviling over the check plots and also over the previous year's infestation. This was particularly striking in the plot where all the trees were banded at the leader. Here the trees weeviled decreased from 51 per cent to 12 per cent or 39 per cent. In the other plot there was a decrease from 27 per cent to 15 per cent (12 per cent). Thus the infestation in 1925 was 24 per cent greater in the plot with all trees banded at the leader than in the others, while in 1926 weeviling in the former decreased 39 per cent as against 12 per cent in the latter, or more than three times as much. The check plots around Plot 1 showed an average infestation in 1925 of 37 per cent and in 1926 of 57 per cent. Those around Plot 2 showed an average infestation in 1925 of 21 per cent and in 1926 of 35 per cent. Infestation in the check plots thus increased materially in both cases at the same time that it decreased materially in the banded plots. The fact that trees banded at the bottom were weeviled shows that the weevils do not necessarily have to crawl up the trees, although a number were caught in the tanglefoot at the bottom which shows that they do crawl up. The data from the other plot show that they will fly directly to the leader, but the fact remains that a great many trees are reached some other way. This must therefore be by flying to some other part of the tree than the leader and then crawling up to the leader. Thus we find that the weevils may get to the leader by one of three ways, crawling up the stem from the ground, flying to any part of the tree itself and then crawling up the rest of the way, and by flying directly to the leader itself. In both treated plots a number of weevils were caught in the bands at the base and one only in the bands at the leaders. In the plot with the marginal trees only banded at the base 5 weevils were found on 4 trees. In the plots with all trees banded there were 13 weevils in the bands at the bases. That is 10.3 per cent of 4 of the border trees in the first case; 7 per cent in the second case, with 9 of the 13 trees on the border.

Attack Young Trees

Weeviling usually begins when the trees are two or three feet high, and five or six years old, but occasionally earlier. When trees two feet high are weeviled they are usually killed back to the last whorl of laterals, resulting in a scrubby tree. Beginning with a minimum height of two or three feet the rate of infestation in widely spaced pure stands becomes increasingly greater reaching the peak at about seventeen feet. From this point it decreases until at a height of 60 feet it is practically negligible. Occasionally leaders have been found weeviled at a height

of 88 feet. In old field pine in the New England States, it has been found that about one-half of the weeviling occurs before the trees are 30 feet high and while the weevilings above are not so important, nevertheless it is important to consider them in attempting to formulate adequate control measures.

Control Measures

The problem of keeping the white pine weevil in check and controlling the injury resulting from weeviling must be considered from a number of angles. The most important are the cost and the completeness of the control measures. For convenience these measures may be classed as direct or indirect.

Under direct or artificial methods we have:

(1) Collection of the adults from the leaders during the feeding period after they have come out of hibernation and before the females begin to lay eggs. This period of feeding is very short—not over a week and great care must be exercised to get all the weevils. Several collections must of course be made in each plantation as the weevils do not come out at the same time. As the weevils feed on the buds care must be taken that all of the weevils are removed, and they cannot be dislodged by jarring the leader. This is a practical means with ornamental trees, but the cost is too great in a plantation or over a wide area.

(2) The removal of weeviled leaders after they have wilted. The cost of this method is not excessive if carried out from year to year from the time the trees are liable to weeviling and the weeviling will not increase to any extent over a period of years. The cost of course is dependent upon the rate of infestation and the height of the trees. If not begun until 3 or 4 years after the weevils first get into the plantation or stand, the cost will be much greater, for there will have been a concentration of weevils for that period. In several plantations where the leaders have been removed the cost has ranged from 25 cents to $2.00 an acre per year. The plantation should be gone over at least twice each season, the second time to remove those which were missed the first time, as well as the ones weeviled since the first removal. If this method is carried out every year from the time the trees are first liable to infestation until such a time as they are too high to be reached by hand (about 9 feet) the severity of infestation will be greatly lessened over the area as a whole, during that time and for a number of years thereafter as stated before. The cost should not be excessive if the work is begun at the time weeviling is first noticed. It will at least insure a much larger number of straight butt logs, and that is the meat of the tree. The amount of crook which will necessarily occur, can be largely overcome by the following additional method. The bud clusters on all but one lateral should be removed.

This seems to result in the remaining lateral absorbing all the available nutrient materials which would have gone to the other laterals as well as the amount it would have normally used itself. Removing the bud clusters does not impair the growth efficiency as much as if the entire length of each lateral was removed. That is, the amount of leaf surface is not reduced as would be the case if the entire lateral was removed. The laterals so treated do not grow appreciably and there is no wound at their bases, as would occur if the whole of the lateral were removed.

The leaders as they are removed may either be burned or placed in screened receptacles. Burning the leaders is the one absolutely sure means of destroying all of the weevil larvae. If however the leaders are placed in screened receptacles there is the added value in allowing the escape of the parasites and predatory insects. These receptacles should be tight—with wire screening of a mesh large enough to allow the parasites to escape, and yet small enough to keep in the weevils. It has been found that 12 or 14 mesh wire is the best suited for this purpose. A few of the very smallest weevils may emerge through this 12 mesh, but if 16 mesh is used as has heretofore been advised, only the smaller parasites can get through, whereas the two most important parasites over the whole range of the weevil find it hard to squeeze themselves through. These receptacles should be so placed that water will not collect in them, and they should be left in the plantations until the following spring. By that time the weevils will all have died and the parasites which wintered over as larvae will emerge in the plantation.

Sprays May Be Used

(3) The use of sprays and repellents has been rather extensively experimented with in plantations. Good results have been obtained with lime-sulphur, in a proportion of 10 ounces to 8 quarts water, and lead arsenate in a proportion of 2 ounces to 8 quarts of water. These were used on an area of approximately 3.1 acres—1 acre was sprayed with lime-sulphur, one acre with lead arsenate and one left as a check. In both cases the infestation was reduced about one-half, although the infestation in this particular plantation was very low—3% on the check area—1.7% on the lime-sulphur area—1.1% on the lead arsenate area. The cost of spraying was $1.45 for the lead arsenate, and $1.70 for the lime-sulphur. The cost, which is mostly for labor, in an extensive plantation might be reduced, but not to any extent. Much of the spray material is wasted as it is very difficult to obtain a nozzle that will concentrate all the spray on the leader itself, and at least one-half of the material is wasted. It may be said that the majority of the leaders infested in the two treated areas, were weeviled afer the material had been washed off by a heavy rain. More work with repellents is necessary. This method means the saving of

the leaders and consequently straight stems. At the present time the cost is too great to use this method to any extent in plantations.

Banding Helps Some

(4) Banding the trees with some material which will prevent the weevils from getting to the leader except on the wing, as related before, is very effective and will reduce the rate of infestation very noticeably. It is of value in preventing weeviling on ornamental

Photo A. C. Cline

b. Mixed White Pine and Hemlock. 60 years old. A marked contrast to Photo c.

trees but from the standpoint of the owner of an extensive plantation it is too expensive.

Photo P. R. Gast

c. Groupwise mixture of White Pine and Hardwoods. This type is remarkably free from weeviling.

Under indirect or natural control measures we have all those measures which are brought about by nature aided by man.

These control measures can usually be effected through silvicultural management planned for that purpose. In any given locality there are certain features peculiar to that particular geological unit. All these factors must be considered in the establishment and maintenance of a forest. A silvicultural method which is efficient in one locality may be relatively inefficient in another locality where the conditions are not the same.

Grow Pines In Mixtures

It happens that the most advantageous way to grow white pine in order to get the most protection against the weevil—is to grow it in mixture with some other species. It has been observed that wherever pine occurs with hardwoods or hemlock the amount of weeviling is remarkably small. It has generally been considered that this is because the pines are shaded from the sun and the surrounding trees act as a barrier against flight. These reasons partly explain the small infestation but the fact that groups of pine surrounded with hardwoods are not weeviled to any extent, even though pure stands of the same age nearby have been weeviled repeatedly, indicates that there are other reasons. It has been observed that adults will feed more readily on pine growing by itself than on pine growing in mixture with hardwoods. Just why this is we are unable to say at the present time. Experiments under way now will not be completed for some time and nothing authentic is available.

Another advantage in growing pine in mixture with other species, preferably hardwoods or hemlock, is that it cleans itself of its lower branches relatively early in life. The limbs on pure pine persist for many years and even in dense stands the branches, while small, will persist for a long time. There will not be so many pines in a mature mixed stand as in a pure pine stand but the ones surviving will be clean boled and straight. In a region heavily infested by weevils comparatively little of the pure pasture pine or the widely spaced plantations will be straight and free enough from limbs to be sold as high grade lumber.

The amount of attention necessary to grow pine in mixture with hardwoods varies with the soil and the species of hardwoods. It has been found that in natural stands the pines and hardwoods tend to occur in separate groups. By judicious weeding, so that the pines will not be crowded out these pine groups can be kept fairly segregated and the final stand will contain groups of pine of much better quality than can be grown in pure pine stands. After a logging operation, the hardwoods tend to come in in groups. A groupwise mixture can be obtained in such conditions by filling in with pine the areas not covered by hardwoods. Weeding will be necessary in the early years, to prevent

crowding out, and a thinning may also be advisable as the stand becomes older.

Photo A. C. Cline

d. Old Field Pine—60 years old. Low density. Repeatedly weeviled and with persistent limbs.

If we could go back [illegible] years we would find practically no pure pine stands on heavy [illegible]. White pine formerly grew with hardwoods and

to a lesser extent softwoods—either singly or in groups. There probably were pure stands on sandy soils and they probably were badly weeviled. Forest investigations have repeatedly shown that it is wiser to follow the principles laid down by nature than to attempt to grow unnatural stands.

Protection In Thick Stands

The number of trees per acre in the pure stand has a bearing on the rate of infestation; as the number of trees increase the rate of weeviling decreases. In 80 plots where the number of trees was less than 1200 per acre, or approximately 6x6, the average per cent of weeviling was 54. In 22 where the number of trees was over 1200 but under 1750 or approximately 5x5 the per cent of weeviling was 47. In 14 plots where the number of trees was over 1750 per acre the per cent of weeviling was 11.1. In 5 plots where the number of trees per acre was over 2750, approximately 4x4 or closer, the per cent was 8. To obtain these figures these plots were taken irrespective of whether they were in pure or mixed stands. Pure pine will show a higher per cent in the widely spaced stands. It must be remembered, however, that a fully stocked stand at 60 years will contain 300-400 trees per acre, thus necessitating several thinnings in the case of a densely stocked stand at the beginning. Of course the cost of close spacing in pure plantations will at least be partly offset by the improved quality of the trees remaining. It has also been observed that the widely spaced pines are fed on more readily than stands where there are a great number of stems per acre. The reason is probably the same as for mixed stands.

Soil and Exposure Important

The soil conditions are of great importance. It is generally understood that white pine will grow on almost any kind of soil. The fact remains, however, that it will not thrive on all kinds of soil. Fro observations that have been made it seems that weeviling is more prevalent in stands on certain kinds of soils. Plantations on sandy soils generally show the highest rate of infestation with sandy loam next. This may be because on a sandy soil we usually have conifers and a resulting porous litter which would be more suitable for hibernation. A wet cold soil generally has little weeviling, but the trees do not grow well either.

The exposure also appears to have a direct bearing on the amount of weeviling. Generally there will be a higher rate of infestation on the exposure getting the morning sun, that is the east and south. This holds true when you have different exposures in the same stand. There are exceptions of course to this fact, but usually when stands on a western or northern exposure are weeviled to a large extent, it can be explained by the fact that there is little if any other pine nearby. The steeper the slope the less the weeviling, and the weevils

will fly over trees on a west or north slope to get to the trees at the top—that is going toward the sun. I have in mind a plantation which is partly on a rather steep slope with west exposure and partly on a very gentle southeast slope at the top of the west slope. Soil conditions are the same. The only natural pine nearby is across the road from the bottom of the west slope. It is about 25 yards away and has been weeviled repeatedly. The percentage of weeviling on the west slope is 37.4, while on the southeast slope it is 64. On the west exposure only 25 per cent are weeviled more than once, while on the southeast slope this increases to 50 per cent. The actual number of weevilings in the tenth acre plot on the west slope on 107 trees is 50, and in the tenth acre plot on the southeast slope on 64 trees it is 67. The weevils necessarily had to fly up the west slope, over the trees to the southeast slope, and as I stated before they flew toward the sun. Part of this same plantation, on the west slope was under hardwoods. A tenth acre plot here shows 19 per cent weeviling in 74 trees with only three weeviled twice, and all but two of the trees weeviled were unprotected.

Parasitic Control Uncertain

Under biological methods we have parasites and predatory agents.

Control of the white pine weevil by parasites is a very uncertain method. They cannot be left out of consideration, however, as they are of great value, but it seems impossible under the present conditions to breed and liberate parasites in large enough numbers to be effective. We have spent a great deal of time the past two summers studying the parasites and we have found that it would take a great deal more money than we now have at our disposal to do anything at all in controlling the weevil over even a limited area thru parasitism. We have collected or bred from weeviled leaders, parasites and predators, but not all of these are numerous. Four or five offer considerable promise if they could be bred and liberated in large numbers, but at this time that is impossible. The two most important, *Eurytoma pissodis Girault* and *Lonchaea laticornis, Mg.* are external feeders.

Predatory agents — chiefly birds, are of great value as a means of natural control. Through protection of insectivorous birds, I believe we may get a greater degree of control than by any other biological method. In one plantation carefully observed the past summer nearly 30 per cent of the leaders weeviled were stripped by birds, and the larvae eaten. In these all the larvae had been destroyed, and in many cases those which had pupated early in the season had also been picked out of the pupal chambers. The birds actually observed feeding on the larvae are chickadees, downy woodpecker, nuthatch and certain warblers. Possibly other insectivorous birds also feed on the larvae if conditions are right.

Summary

In summarizing I will frankly say that I believe the most advantageous and cheapest way to grow white pine to protect it from the weevil and to control the injury is to grow it in mixtures, preferably with species that will be of value in the final crop. Hemlock and the better hardwoods, such as oak, ash, hard maple, are advised. Weedings from time to time in the early stages will be necessary so that the pine will not be crowded out. Thinnings may be needed as the stand becomes older.

In pure stands, both natural and artificial, the greater the number of trees per acre the less the weevilings. In widely spaced stands it is advisable to remove weeviled leaders from the time the stand is liable to infestation until the leaders are too high to be reached by hand. This will ensure a relatively large number of trees per acre which will have a good butt log.

Parasites and predatory agents should be encouraged as much as possible. Birds particularly seem to be of great value.

GIPSY MOTH CONTROL

By H. L. McIntyre,

Supervisor of Gypsy Moth Control, New York State Conservation Commission

THREE years' accomplishments in New York State's campaign to repel the gipsy moth invasion from New England and save New York forests, orchards and shade trees from this dangerous tree pest that has caused millions of dollars worth of damage in New England, was told by Mr. McIntyre.

"For some seventeen years" said Mr. McIntyre, the spread of the Gipsey Moth, the country's most serious forest insect pest, advanced in a westward direction at the rate of six miles per year.

"In 1922 it was found that the solid infested area had gradually moved to the eastern New York boundary, and in fact had crossed into New York State in Rensselaer county.

"In 1923 still further colonies were found on the western boundaries of the State in Dutchess county. This fact aroused the desire of the Conservation Commission to prevent this insect from getting a foothold in the State and particularly to prevent, if possible, its establishment in the Adirondack and Catskill mountain sections, where extermination work would be very hazardous and extremely expensive.

"With this in view, the campaign was inaugurated in 1923. The work has resulted in the discovery of some forty quite well established colonies, at which control work has been vigorously and apparently successfully carried out. Had these colonies been left unmolested until this date, there is no doubt that at this time quite a general infestation would exist in the Hudson Valley and the areas to the west.

"To date," the speaker declared, "that the campaign has been quite successful and it might be considered by some that the conditions that have existed in New England for the past few years are factors in the success that has attained the work in New York State. This part of the problem, however, if investigated, will reveal that during the past two years the most extensive depredation by the Gipsy Moth that has been recorded for years was present in eastern New England, and again, during the past summer some of the largest colonies that have ever been reported in the Connecticut valley in New England have been found. The bearing that these facts will have upon the work of the Conservation Commission can only be determined through time and the continuance of the vigorous exclusion program that has been undertaken."

WILD LIFE AND FOREST REPRODUCTION

By Professor A. V. S. Pulling,

Roosevelt Wild Life Forest Experiment Station, Syracuse, N. Y.

When this subject was assigned, it was limited to wild life damage to trees in the *reproduction* stage. This eliminates wild life injury to seeds; also to mature trees, though, in some cases, damage to reproduction later results in a greatly reduced value from older specimens.

I am going to discuss it from the viewpoint of the forester rather than from any other angle, though we must consider the attitude of the technical zoologist, the nature lover, the trapper, the hunter, and the farm woodlot owner, I am arbitrarily limiting the discussion still further by ignoring possible bird damage, and considering mammals only, and those, for the most part in Northeastern United States and Eastern Canada.

Any studies of the relation of wild life to forest reproduction are naturally grouped under three heads:

1. A discussion of the animals that do the damage.

II. Methods of eliminating or reducing this damage.

III. Consideration of whether or not the animal is sufficiently valuable to justify the injury it does.

Again, under heading I, animals that injure forest reproduction may be grouped according to the type of damage they do. These would be as follows:

1. The rodents and rabbits, including the wood mice, porcupines, beaver, cottentails, varying hares, and jack rabbits imported from the West. Squirrels damage to buds and bark in some sections is slight, in others quite severe. As seed destroyers they are most important, but they are outside the limits of this paper.

2. The browsers or twig eaters, including only the deer family.

A possible third group may later become a factor. I refer to the wild hogs of Europe that have been introduced into at least the Whitney Preserve in the Adirondacks. Their work is similar to that of the more or less domestic hogs that range the southern forests. They are not important enough to deserve more than a passing word.

Mice Damage Not Serious

To return to the first group and the details of their damage and control.

The mice are the logical animals that should first be considered. In such a brief paper, the work of the different mouse species should hardly be separated. Indeed, mice are so little known in this connection, and my field experience with them is so slight, that individual species may well be ignored. Mouse damage to seed is much greater than mouse damage to reproduction, so little need be said. Mouse injury to reproduction is confined solely to bark gnawing, and almost entirely to barking small trees beneath the snow surface. The species that do the most damage in the woods are probably the white-footed mouse (Peromyscus leucopus) in high ground, the field mouse (Microtus pennsylvanicus) and the red backed mouse (Evotmys gapperi) in more grassy locations. Other species, such as the lemming mouse and pine mouse may be important. The species are of little moment. Most wild mice eat young bark if other food is scarce. Fortunately, damage is generally local, is usually restricted to inferior hardwoods, and is probably the least important of all the animal damage we are considering.

The Germans use poisoned grain or bread extensively for killing mice to protect seed spots or broadcasting. This would be expensive, dangerous to birds, and highly questionable in this country. A fair abundance of hawks, owls, shrews, foxes, raccoons, and various members of the weasel family will keep mice from doing any serious damage to reproduction. Natural control may be fairly effective, and is certainly inexpensive.

Mice *might* be locally exterminated without dangerous results. But this is unlikely. Their natural enemies are being reduced, so the mice may increase. House mice and common rats are being fought mercilessly, but they appear to be holding their own. Fortunately, these introduced animals do not live, in the North, away from buiildings in cold weather.

Rabbits Asset As Game

Rabbits and hares do precisely the same type of damage as mice. Again, it is rarely serious, and generally local. Inferior shrubs are often girdled. Poplars are probably most often attacked in the woods. Any fruit trees, on neighboring farms, may suffer the most damage, unless they are protected by wire mesh bands. Rabbits are hard to exterminate in the woods, where large forest conditions prevail. They are an asset from the standpoint of game, they are the principal food of many important fur animals, and in general justify the slight damage they do. If the predacious mammals and birds do not keep them down, winter hunting with hounds or winter snaring will reduce them all too quickly. The varying hare (Lepus americanus) is the worst offender

in the Northern Forest, and he periodically dies from disease, perhaps as a result of over-population, after becoming too plentiful. Again natural control and seasonable hunting will be ample to properly control Eastern rabbits where they are sufficiently common to need control.

Extermination Dangerous

To return to the rodents, we must now consider two animals, the porcupine and beaver, neither of which could be more than briefly discussed if it consumed all the time devoted to this paper.

The porcupine (often erroneously called hedge-hog) has few friends. It is a dirty, noisy, gnawing nuisance around woods settlements. It is sometimes defended, and even protected, because it is said a lost traveler can kill one for food without a gun. Natural control is not practicable. Few wild animals will kill a porcupine, and then it is usually when driven to the last extremity of boldness by hunger. Wolverines are said to kill them extensively. Bears and Canadian lynxes may kill them occasionally. I have known a dog or two to kill porcupines, but they finished the fight well filled with quills and would probably have died without man's help. I picked up a dead fox in March, 1917, with her face full of quills. Whether or not she finished the porcupine is not known.

People kill porcupines because they are stupid wild animals and a bounty of fifty cents each would probably cause them to become scarce locally. "Extermination" is a dangerous term, even when applied to a noxious animal, providing it is less noxious than flies, mosquitoes, mice and rats. The Biological Survey hunters have waged a war of extermination on wolves, coyotes, and other predacious animals of the West, in order to protect stock. Then, their natural enemies being exterminated, the next problem was to exterminate prairie dogs and other rodents that may have been held in check by the wolves. The idea seems to be to exterminate everything.

So I would not exterminate the porcupine without further evidence. I usually kill on sight any that are around my own camp, but that is a small local matter. Porcupine damage to trees, both East and West, is considerable. Their winter food is almost entirely bark, and their appetites are peculiar. In one section of New Hampshire, white pine bark was their favorite food, and 100 per cent of the local pine was injured. Many were killed, and many others rendered almost worthless for timber. Only a few miles from this New Hampshire area, on the sides of Piermont Mountain, beech was the only tree taken. In the university woods, near Fredericton, New Brunswick, tamarack was barked almost to the exclusion of other trees, while some fifty miles away in the Cains River valley, jack pine (Pinus divaricata) was extensively eaten; yet few other trees were disturbed. They are local problems, in the local forests, and, where present, their proper control must be considered in any working plan.

Beaver Is Important

The beaver is the last and in many ways the most important member of the rodent group that is concerned in forest protection. There are few beaver in the Eastern states except in the Adirondacks and Northern Maine. Dr. Charles E. Johnson, acting director of the Roosevelt Wild Life Forest Experiment Station, has studied the Adirondack beaver very carefully. The Roosevelt Station Bulletin, Vol. 1, No. 2, which he wrote in 1922, is unfortunately out of print. It detailed Dr. Johnson's observations on the beaver very carefully. He is preparing a new beaver bulletin, that I hope will be published within the year, that will include the latest available information. The beaver, even more than the porcupine, still demands much study.

The beaver problem in New York is partially economic, partly sentimental and educational. Enemies of the beaver usually present the following accusations:

1. Beaver are destroying valuable timber by felling.
2. Beaver are killing forests by flooding.
3. Beaver are injuring trout by building dams.

It is quite true that beaver cut many trees. Poplar is their favorite food. Alder is eaten extensively. Both the white and yellow birches are common victims, and beaver will occasionally cut anything, including balsam fir and spruce. But most of the trees cut are of inferior species. Most trees cut are in inaccessible, hard-to-log valleys. And more important still, nearly all beaver in New York are in the forest preserve counties, where Article VII, Section 7, of the State Constitution prohibits the cutting of timber. The beaver are unfamiliar with the Constitution, or else they are naturally lawless, for they continue to cut without regard to legal provisions. Of course this phase of the situation is of interest only in New York. All Northeastern States can, if they wish, have beaver along their waterways.

Relative to forest damage by flooding, careful check-ups have shown that in many instances, beaver flows flooded land that was so low that only alders, willows, and other inferior species grew there in any quantity. Occasionally a little real forest land is put out of commission by flooding. There are instances where a certain beaver colony should be eliminated. When someone reports great local "damage" from a colony of half a dozen beaver, the reporter may be considering the hundred dollars worth of fur those beaver are carrying around, and he logically wants the hundred dollars more than he wants the beaver. Dr. Johnson estimates the number of beaver skins taken in March 1924, in the Adirondacks to be about 5,000 and to be worth from $15. to $20. each, as a fair average price. He believes that this income can be maintained or even increased with proper beaver management. Particularly in the Adirondacks, where logging is prohibited, this is no small

forest product. I have yet to see a beaver flow where the skins of the inhabiting beaver would be insufficient to pay for this injured stumpage and land rent. In many instances, the skins would more than buy the flooded land at the highest market price.

Relative to trout damage rather than being injurious, dams may increase the water area, thereby increasing available feeding grounds for trout, and the trout waters may thus be improved. Trout may be somewhat hampered in running up stream to spawn in dam-choked streams, but this has not affected them in any section under my observation. I have heard a few men almost intimate that beaver ate trout! The fact is, many trout enthusiasts are trying to blame something else for a scarcity of fish instead of overfishing, pollution and deforestation —all caused by man. Beaver and trout inhabited the same waters very peacably for many centuries, doubtless always in a very fair state of equilibrium, before this equilibrium was upset.

Moose and Deer Similar

The second and smaller group of animals that injure forest reproduction are, as was mentioned sometime since, the deer family. The only species in the East of importance, is, of course, the ordinary Eastern while-tail. The moose has ceased to be a factor in the Eastern United States, though it still persists in Maine. The feeding habits and winter food of the moose is so like the deer that injury is similar, except that the moose is so tall that he can browse much higher. The caribou of Canada — even woodland caribou, are supposed to feed heavly on lichens, and do little browsing. Elk (wapiti) were originally native here, and efforts have been made to bring them back. They graze rather than browse, though, of course, all deer browse to some extent so far as I can find out.

Most moose and deer damage is confined to the twigs of poplar, maple, hemlock, balsam fir, and white cedar, so far as my observations go. White pine and the spruces are sometimes slightly browsed, as are the twigs of almost any shrub or small tree near a deer yard in a snowy winter. Starving deer or moose are no different than starving cattle. They take what they can get and sometimes gnaw large branches of almost any tree species.

Deer have been increasing in the East, though the bad spring of 1926 reduced them in part of the Adirondacks. It is hoped that deer management will also be considered in working plans, and that every deer's potential value — not in terms of pounds of meat but in terms of what a sportsman will spend — will be estimated in forest valuation. Extermination is all too simple. Management will consist in having an adequate food supply, proper protection and a generally suitable habitat. Deer usually congregate in slashes or burns to eat the young sprout growth. A burn or slash growing up to maple and

and poplar sprouts alongside a cedar swamp or spruce thicket area is ideal winter quarters. This can be easily enough arranged. In fact burn and slash is all too common! Deer have tough picking in old growth upland forests. A plantation surrounded by old growth might be badly injured if the animals wintered in the vicinity. Deer, of course, live on aquatic vegetation in the summer, insofar as they can get it, so real reproduction damage is confined to a few winter months. Again, both deer and moose are highly selective browsers. They usually move steadily as they feed, daintily nipping a small twig here and there. The feeding is so extended that the damage is slight. It is in no way comparable to the deliberate devouring by cattle, the stripping by great herds of sheep, the voracious feeding of goats, the browsing and tramping of horses, or the intensive rooting of hogs. Only around a yard in deep snow, do any of the cervidae approach domestic stock in their intensity of browsing. Both bucks and bulls sometimes demolish a small tree in rubbing the velvet off their antlers, or perhaps just to get in trim for fighting a rival during the rutting season. This injury may not be great, but it deserves weighing and considering.

Food, cover and breeding grounds are the essentials in deer management, and frequent clear cuttings on small areas with resulting sprout growths will produce sufficient food supply to eliminate serious damage. Cutting hemlock, balsam and cedar as well as various hardwoods, in winter is also a boon to the deer. I have seen them browse tops and brush piles within plain sight of the loggers. Many deer, if not frightened, will follow the logging roads and yarding trails, living on twigs from freshly cut slash. If it happens to be a beech nut season, the deer will paw for nuts, even through fairly deep snow and thus relieve young trees from possible browsing.

Deer damage may be considerable and deer control may be locally necessary, but deer management, the same as all wild life management, is a logical part of forest management, and should always be treated as such.

Summary

In concluding, the relation of wild animals to forest reproduction may be summarized as follows:

1. Small rodents do relatively little damage, are useless to man themselves, and are economically held in check by natural enemies, rather than by man.

2. Large rodents and rabbits may be very injurious to the forest. They may or may not be valuable economically; they are sometimes only slightly affected by natural control; in other cases — as rabbits — well controlled naturally they may be easily controlled by man in a well managed forest. In the case of the beaver, the fur may be by far more valuable than the stumpage destroyed or the land occupied.

3. Browsing enemies may be very injurious. But they are valuable

from the viewpoint of sport, they are easily controlled — in fact can be exterminated at will if the law permits, and are rarely more than a local menace to reproduction.

4. Animal management should be included in any good forest working plan and animals should be considered in forest protection.

5. Extermination of any species should not be considered unless it has been definitely proven to be so destructive to the forest that local control is insufficient to hold it in check. I am not sure that we should attempt to exterminate *any* native wild animal in the Northeastern United States or Eastern Canada.

FEDERAL COOPERATION WITH THE STATES IN PROTECTION AGAINST FOREST FIRES

By C. R. Tillotson,

District Inspector United States Forest Service, Amherst, Mass.

PROTECTION against forest fires is being developed along two lines — direct and indirect. The *former* has to do with the methods which focus attention and efforts directly upon the fire problem; the *latter* builds up an appreciation of timber as a resource and gradually brings about a forest consciousness, when timber protection follows as a matter of course. Federal aid to the States has been and is a mixture of both methods. The former, represented by Weeks Law and Clark-McNary Law assistance, is the more evident and perhaps more appreciated kind of cooperative aid; the latter, represented by general forestry studies and educational efforts, is less realized and appreciated and its immediate effects difficult to measure. Who will say, however, that in the long run, the latter is not fully as potent if not more so than the former?

It is hardly necessary to go very far into a discussion of the Weeks law, which first made possible direct Federal financial assistance to the States in meeting their forest fire problems. Suffice it to say that the law enacted in 1911 established the principle of a nation-wide interest in State and privately owned timber at the headwaters of navigable streams and an obligation on the part of the Federal government to assist the States in its protection against fires. Federal assistance was predicated upon some provisions considered essential to insure reasonably effective expenditure of the Federal funds and at least an equal amount of State funds. An initial appropriation of $200,000 was provided and this was gradually increased to $400,000 in the Federal fiscal year 1925. Eleven States, including New York and all New England States except Rhode Island, availed themselves of co-operation n 1911. Rhode Island began to participate in 1918.

How Clark-McNary Law Works

On June 7, 1924, the Clarke-McNary act was approved by the President and became a law. It supplanted the Weeks law in so far as Federal participation in the protection of State and privately owned timberlands was concerned. It broadened the principle of Federal cooperation by giving the Secretary of Agriculture authority in his

discretion to extend cooperation to any timbered or forest producing lands or watersheds from which water is secured for domestic use or irrigation within the cooperating States. The immediate effect of this provision has been to extend Federal participation in protecting all timberlands in cooperating States and to some of the chaparral brush lands of Southern California which are of extreme economic importance to that region as a protective watershed cover.

There are other changes of consequence. Whereas the Weeks law authorized the Secretary of Agriculture to cooperate with the several States under such conditions as he deemed wise, the Clark-McNary law authorizes and directs him to cooperate with any state whose system and practice of forest fire prevention and suppression substantially promote adequate protection of the timbered and cut-over lands. Cooperation in actual prevention and suppression effort under Section 2 of the law is somewhat dependent upon the attainment by the States of the objectives set up by Section 1 of the law. In this, the Secretary of Agriculture is "authorized and directed, in cooperation with appropriate officials of the various States or other suitable agencies to recommend for each forest region of the United States such systems of forest fire prevention and suppression as will adequately protect the timbered and cut-over lands." Obviously the purpose of this section is to obtain a clear cut perspective of the fire problem in each region, to set up reasonable objectives, and to outline measures and methods designed to attain them. Since the recommendations required by Section 1 of the law are to be made by the Secretary of Agriculture in cooperation with appropriate officials of the various States or other suitable agencies, it is reasonable to expect that the recommendations will be put into effect as rapidly as possible.

Rule of Reason Applied

It appears reasonable also that financial aid from the Federal government should be conditioned upon satisfactory progress in that respect. Such a course would doubtless strengthen the hands of the responsible State officials. There will of course be no disposition on the part of the Federal government to insist blindly upon adherence to a program mutually acceptable at the time of its launching. The rule of reason will be applied and such modification made from time to time as are dictated by changes in conditions and as are mutually satisfactory to both State and Federal authorities.

Up to the present, there has been no great disposition on the part of State foresters to avail themselves of the opportunity which Section 1 holds out for a bringing together of facts and an analysis of the forest fire situation in their States. Of the Northeastern States, Maine is the only one to date. Possibly others will follow. The Federal Government is not trying to influence the States of this region to agree

upon a definite cooperative project under this Section because progress and accomplishment are already marked as compared to other regions. The purposes of the law can be met for the present, at least, through the contact which the Federal inspector has with the State officials that enables him to discuss with them their problems and work out with them the means of bettering unfavorable situations, etc. This will, in fact, be a means of developing an adequate system of forest fire prevention and suppression without resort to the "big stick" idea, a course that is just as objectionable to the Forest Service as it would be to the States.

Public Education Needed

In passing beyond the discussion of Section 1 of the law, I do not want to leave the impression that all is well in New York and the New England States. Fifty thousand fires burning an area of 140,000 acres and causing $600,000 damages is the average record for each of the last ten years. The fires are practically 100 per cent due to preventable causes. Only a very few are due to that scourge of some of the high western country, lightning. Apparently there is a big problem here in education of possible fire setters. In this age of tobacco smokers, one of the prolific causes of fires, the field is a wide one. Ingenuity and persistent effort of a high order are going to be needed in this continually developing industrial and summer resort region even to maintain the fire record at its present level. A State organization that is not provided with the means for a vigorous and sustained educational drive is going to fall behind. At present, educational efforts are not so well organized as they should be. Usually, this is due to a lack of funds. The remedy accordingly is obvious. Perhaps, the States would not look with disfavor upon an insistence by the Federal government that a suitable portion of the Clarke-McNary funds be devoted to educational work where that appears to be an outstanding need. There is even some need of educating the forest fire organizations in the matter of the values destroyed by fires. Too many reports on fires which are submitted to state foresters bear the brief statement of "No damage." That indicates a lack of appreciation of forest values which certainly should not exist in minds of forest fire wardens.

It is not my purpose here, however, to go into the weaknesses of State organizations. All are more or less inflicted and State foresters as a rule know where the faults lie. They are often powerless to overcome them except in a very indirect and time-consuming way. It is the hope of the Federal Service that the Clarke-McNary Law may help to bring about a solution at least of some of their vexing problems.

Co-operative Funds Explained

In the direct application of Section 2 of the Clarke-McNary Law, funds are alloted to the States in the same manner as under the Weeks law. The Federal appropriation is divided among the cooperating

States in the ration that it bears to the total cost of protection in those States. During the present year, the allotment to each State is 7.4 per cent of the estimated total cost of adequate protection. To illustrate: in the case of New York, the estimated cost each year of adequate forest fire protection is $388,500. The Federal allotment is 7.4 per cent of that, or $28,750. As the Federal appropriation grows enough to permit it, it is expected to allot each State at a flat rate of 10 per cent of the cost of adequate protection and beyond that to allot any balance in proportion to the expenditures which the States themselves are making. For instance, a Federal appropriation of $1,000,000 would enable the Forest Service to set aside for New York an initial allotment of $38,850 and an additional sum of about $6,000, or nearly $45,000 in all.

This assumes that State and private funds available for expenditure in all of the States remain as at present. You will all be interested to know that a $1,000,000 appropriation is within the realm of probability since the Director of the Budget has indicated a willingness to approve an estimate of that amount. If he does, it will then be up to Congress. An appropriation which would enable the Forest Service to distribute a part of the fund upon the basis of State effort would be just as gratifying to the Forest Service as it would be to the States benefiting. Even a million dollar appropriation, however, will not permit the Federal government to bear what it considers an equitable share of the total cost of adequate protection of State and privately owned timberlands. That total estimated cost is $10,000,000, of which the Forest Service figures its share at $2,500,000, the sum which is authorized by law and which will doubtless be appropriated in time.

Laws Fulfill Their Purpose

That the Weeks Law and Clarke-McNary Law have in part fulfilled their purpose is indicated by the fact that from a beginning of eleven cooperating States, in 1911, which were giving protection to 60,779,000 acres of forest land, the number has grown to 33, giving protection to 177,482,000 acres. In fairness, I believe it can truthfully be said that a part of this growth is due to the stimulus afforded by these two Federal laws. The system of Federal inspection, which has been conducted entirely in a friendly and helpful spirit, has also brought to States, particularly those which were just embarking upon this line of effort, much that was helpful in the way of suggestions and advice.

Indirect Federal aid to all States in their forest fire problem is something that is doubtless overlooked because it does not parade under any legislation which gives it a cooperative aspect. Nevertheless, the excellent Report upon Forestry by Franklin B. Hough as early as 1878 doubtless had its effect in awakening some interest in our timber resources. Annual reports of the Division of Forestry under the direction of Eggleston, Fernow, and Pinchot, as well as other publications, public

utterances, and activities of these men or others connected with the organization, still further focused public attention upon and created an appreciation of our timber problems. The rapidly expanding activities of the Bureau of Forestry after its creation in 1901 and of the Forest Service from 1905 to date have in effect been cooperation in a broad way because they have supplied information and created favorable sentiment that must have been helpful to State foresters in their various projects of which forest fire protection was only one.

No one, I am sure, will deny the value of such publications as the so-called "Capper Report" in arousing a wide interest among economists and other thinking people, or of the technical and more popular publications which have been distributed by tens of thousands. They are distributed almost wholly in the States, they educate, and they recruit supporters for the State foresters' programs. Do not overlook the National Forests scattered throughout the country where the Forest Service is also attempting to develop adequate forest fire protection measures and practices. It suffers very materially from fires periodically, as was the case during 1926, which indicates that it must keep on striving. Its problems in this respect are just the same as those of the States and the latter can and will benefit from its experiences. This is more true in the Western States, where National Forest lands and State and private lands are intermingled, than it is in the eastern. And further, the studies carried on by the Forest Service which have to do with relative humidity and forest fires, duff moisture in its relation to fires, and the initiation of forest fire weather forecasting, have already proven of very practical value and promise to become more so. The results are available to all who care to make use of them. All of these activities are helpful to the States and can accordingly be considered as cooperation. It may be even more potent cooperation than direct aid in the form of funds.

Timber Production Real Issue

Although this meeting is devoted to the subject of forest protection and this paper is devoted to protection against fire, I should be remiss if I did not bring out that fire prevention and suppression are simply a means to an end. Timber production is the real issue before the American public. Perfection in fire prevention and suppression methods is merely the prelude to the overture of "timber crops on timber lands." Our efforts in bringing about this perfection must not accordingly lead us so far away that we shall forget our main objective and strive by all means to attain it. I am dubious as to whether we are making as much progress in learning how to improve on Nature's way of growing timber, which we all admit is sometimes very unsatisfactory, as we are in improving our forest fire technique. It would indicate sound judgment on the part of those responsible for State forestry activities if some projects other than fire prevention were given a place in the

sun at least equal that accorded fire prevention. Surveys of forest resources, utilization of products, studies of growth, yield, and management of different types of woods, and others designed to meet some of the questions crying for answer should be undertaken if possible. One of our good friends recently complained that we were talking a great deal but not accomplishing much in the way of getting forestry practised on the ground. That is probably due to two things. Perhaps we have not much to say that can be concretely applied in the woods. Then timberland ownership is not upon a stable basis. The present private holders of timberland are for the most part organized upon the basis of "cut out and get out." They are not interested in their land beyond the harvest stage. A new type of ownership will have to come into the field. That is a fact which we must recognize and there is nothing gained by letting out a wail about it.

The opportunity is presented, however, right now for States and municipalities to embark upon a program of timberland acquisition and development while the land is cheap that is more favorable than it may ever be again. In a recent talk before a meeting of State foresters, Col. Greeley expressed his judgment that about one-third of the timberlands of the United States should be under public administration and that a vigorous extension of State forest ownership is desirable. The program contemplated by the Federal government under the Weeks and Clarke-McNary laws will add 8 or 10 million acres to the National Forest lands. If one-third of all timberlands are to come under public administration, 50,000,000 acres more than at present will have to come under State, county, or municipal administration. To quote Col. Greeley, "While we should go right ahead with full steam in developing fire protection, forest taxation and other encouragements of industrial and farm forestry, I doubt if there is any single item in the whole program that will give it greater strength or greater public appeal or a more specific focusing point for public action than State forest ownership on a generous scale. Furthermore, just as more public forest ownership will aid in stabilizing the general situation, equally I believe will it aid in stabilizing the forest policies and forest administrations of the States. The very responsibility and obligations assumed in the public administration of forest land will tend to give State forest organizations the stability, the technical development, and the public standing which they need to function most effectively. This has certainly been true of the National Forest Service. I believe it will be equally true of any State forest service. I would like to suggest the wisdom of a strong drive, featured in a big way, for the extension of State forests, in at least the great majority of our States."

Public forests of this kind will afford the opportunity of learning and applying forestry on the ground and will be most instrumental in its spread to privately owned lands. Perhaps the experience gained would make us, as foresters, less impatient with private owners of timberland.

THE IMPORTANCE OF METEOROLOGICAL STUDIES IN FOREST FIRE PREVENTION

By Paul W. Stickel

Junior Forester, Northeastern Forest Experiment Station, Amherst, Mass.

ANY method or methods which will help to reduce our annual forest fire loss should be used by those of us in charge of our woodlands. We will always have forest fires as long as we cannot control lightning and people are careless. Since we cannot very well lock up our forested lands and thereby exclude the human element responsible for the majority of our fires, the problem must be solved in some other manner. If, for example, we have a means of accurately measuring and forecasting the periods of greatest danger in the forests, a great step can be taken in forest fire prevention work. Extra patrols can be used during these extreme hazardous periods and fire fighting crews held in readiness to get to fires as quickly as possible. In general, the entire protection organization can be prepared. Such information regarding the dangerous periods would be in itself in the nature of an educational campaign for the public, especially if warnings were broadcasted by radio and published by the daily press. The public could not help but exercise due precaution at such times.

The measurement of meteorological factors and an intelligent interpretation of these data gives every indication of furnishing us with just this kind of information. It should not be assumed that this work is a general panacea; the study of meteorological factors can no more prevent forest fires than can a study of crime prevent crime. These studies can only point out facts of direct practical application. Incidentally, it seems to me that we should not limit the use of meteorological studies simply to forest fire prevention. These studies are of extreme value in efficient forest fire suppression, a subject to which I shall refer later.

The importance of the study of meteorological factors to forest fire prevention lies in the fact that these component parts of what we call weather are the direct causes of hazardous conditions in our forest when considered from a fire danger viewpoint. There are two conditions necessary for inflammability: fuel to burn and conditions favorable for combustion. Forest fires will start and spread rapidly in our forests only when the moisture in our leaf litter and duff falls below a definite precentage and when atmospheric conditions are favorable for carrying the fire along.

Rainfall Important Factor

The degree of dryness in the forest floor is dependent primarily upon five major meteorological factors:

1. Precipitation.
2. Air and duff temperature.
3. Evaporation.
4. Wind velocity.
5. Atmospheric humidity.

Of these five meteorological factors only one can be said to be wholly beneficial in reducing forest fires. Rainfall, when frequent and abundant enough, entirely eliminates forest fire seasons; and conversely, the lack of rain creates fire seasons. The other factors may be either beneficial or detrimental, depending upon their character. Relative humidity, the percentage of moisture present in the atmosphere, may be a positive as well as a negative factor in increasing fire hazard. High relative humidities are comparable to rainfall, since a high moisture content in the air keeps moist both the air and the materials on the forest floor. Low relative humidities help to create dangerous conditions, since the dry air with its greater capacity for absorbing moisture tries to make up for the deficit by taking what moisture there is in the leaf litter and duff. Both temperature and wind velocity are factors which can either increase or decrease fire danger: high temperatures, both in the air and in the duff, mean a loss of water from the forest floor by evaporation: while high wind velocity accomplishes the same result both by its direct action and by bringing in the warmer winds from dryer regions. The warm winds with their greater capacity for moisture draw out the water from the forest litter.

Evaporation, while not a direct factor, shows the combined effects of temperature, wind velocity, and relative humidity. With high temperature, high wind velocity, and low relative humidity the evaporation increases. The reverse is true with low temperature, low wind velocity, and high relative humidity. Evaporation also shows the effect of rainfall, since during precipitation evaporation practically ceases. If we were to give these meteorological factors a rating as to their relative beneficial and detrimental effects from a fire prevention viewpoint, rainfall would be placed at the positive end of the scale and the other factors scattered from the positive to the negative end, depending upon their quality. The effect of rainfall in keeping the duff above the inflammability point is limited by the amount and frequency of precipitation. During the dry periods the other factors—air and duff temperature, wind velocity, relative humidity, and evaporation—determine the degree of fire hazard.

Graphs Show Results

To illustrate the close relationship between meteorological conditions and the moisture present in our forest floor — the true index of fire danger — I have prepared two graphs (Figures 1 and 2). These graphs represent typical weekly charts of the duff moisture percentage and the most important meteorological factors. Figure 1 presents the weekly record from a station in a clear cutting in the northern mixed softwood-hardwood forests at Cranberry Lake, New York. Figure 2 is likewise from a clear cutting, but in the white pine type at Petersham, Massachusetts.

The chief points of interest which these graphs bring out are:

1. The close relationship between all the various factors, and especially between relative humidity and duff moisture percentage.
2. The comparatively short lasting effect of rainfall in keeping the duff moist for extended periods of time.
3. The extremely rapid drying out of the duff, not only each day but also after heavy downpours.
4. The periods of extreme danger each day during dry periods.
5. The periods of low fire hazard which occur daily even during the periods of greatest fire danger.

These two graphs show that the march of all these factors,— relative humidity, air temperature, wind velocity, and evaporation — very closely follows the curve of duff moisture percentage. In the Cranberry Lake records the duff moisture at 8 A. M. was always 25 per cent or more. With the increase in air temperature, the corresponding increase in duff temperature, the increase in wind velocity and evaporation, and the decrease in relative humidity, the duff moisture percentages at noon fell below 10 per cent regularly, in some cases going as low as 5 per cent. The curves for duff moisture and relative humidity can almost be superimposed upon each other.

Usually the peaks and depressions of both occur at the same time daily. In the case of the Petersham station, with its extremely low noonday duff moisture of 2½ to 3 per cent and relative humidity of 30 to 35 per cent, this is equally striking. Up to the present time, the factor of duff temperature has not received the attention it should. In this work, duff temperatures of as high as 160° Fahrenheit have been recorded. While it is true that the curves of duff moisture and relative humidity follow each other very closely, I believe that the drying-out process of the duff does not take a very rapid course until the duff has been heated to a temperature at which evaporation begins.

Summer Showers Not Effective Long

There is a strong correlation between relative humidity and duff moisture, as I have pointed out. The occurrence of rain destroys

FIGURE 1

CRANBERRY LAKE, N.Y.

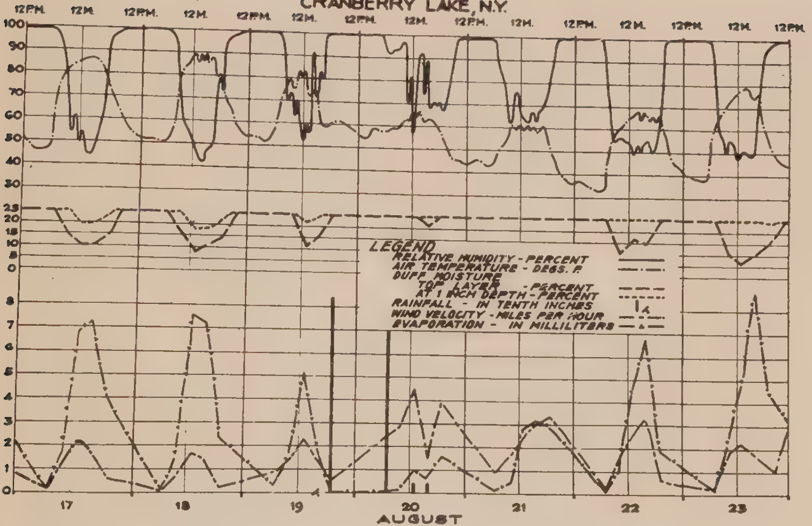
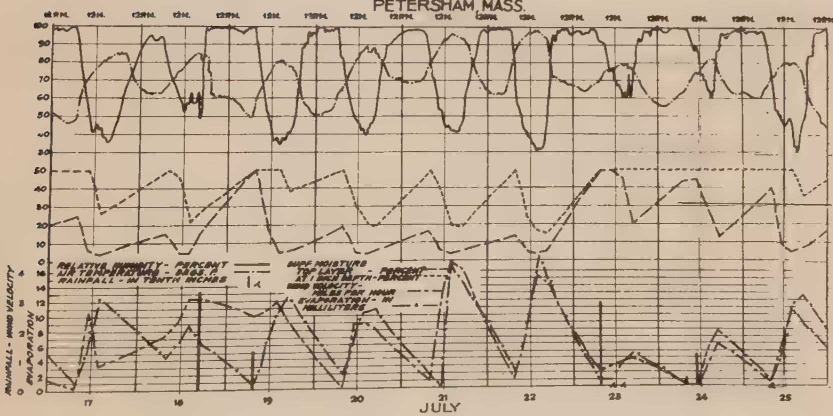


FIGURE 2

PETERSHAM, MASS.



this relationship for a time until the moisture in the atmosphere and that in the materials on the forest floor comes to equilibrium. These two graphs illustrate very strikingly the fact that rainfall does not keep the duff above the danger point nearly as long as we had supposed. Especially is this true during the fire seasons when the precipitation occurs so commonly in the form of heavy, sudden downpours. In the case of the white pine type, .3 of an inch of rainfall, when followed immediately by dry, hot weather, only kept the upper layers of the duff moist for less than 24 hours. The Petersham graph shows that with .3 of an inch of rain the moisture in the top leaf litter dropped to 5 per cent, and the duff at one inch only had 20 per cent moisture content in less than 24 hours after the rainfall. This example well illustrates the fact that the typical late spring and summer showers are of little aid in reducing the fire hazard for any extended period of time.

It will also be noticed that the period of greatest daily fire hazard occurs within comparatively definite limits; and were I to present the entire season's records you would see likewise that this period of greatest danger follows the trend of the seasons. During the later spring and early summer months, this zone of danger lies between the hours of 9 A. M. and 9 P. M., being approximately 12 hours in length. As the season progresses, this period gradually shortens, until during the fall fire season it is not quite half as long as during the early part of the year. In the white pine type at Petersham during October the greatest danger from forest fires occurs between the hours of 11 A. M. and 3 P. M. The reason for this gradual reduction in the daily length of hazard is twofold. The air temperature is slowly becoming cooler, which, when accompanied by the clear fall nights, means a heavier dew. . When the night temperature falls low enough, as it so often does, the dew is turned into hoar frost. Accompanying the cooler air temperatures during the fall there is likewise a reduction in the total daily hours of sunshine.

Since the moisture on the forest floor in the early morning is often in the form of frost, and since the high air temperature during the day is reduced, not only in intensity, but also in duration, it follows that there should be a reduction in the hours of greatest danger, since besides the smaller amount of heat, part of this heat must first reduce the frost to water before it can be evaporated. It appears that relative humidity plays a minor role during the fall forest fire season, for although in October relative humidities were recorded as low as those during the spring the moisture percentage in the duff was much higher. In general, it appears that the daily period of greatest fire hazard follows the daily length of sunlight. The longer the sun's rays remain on the ground and heat up the duff, the longer is the duff moisture below the inflammability point.

FIGURE 3

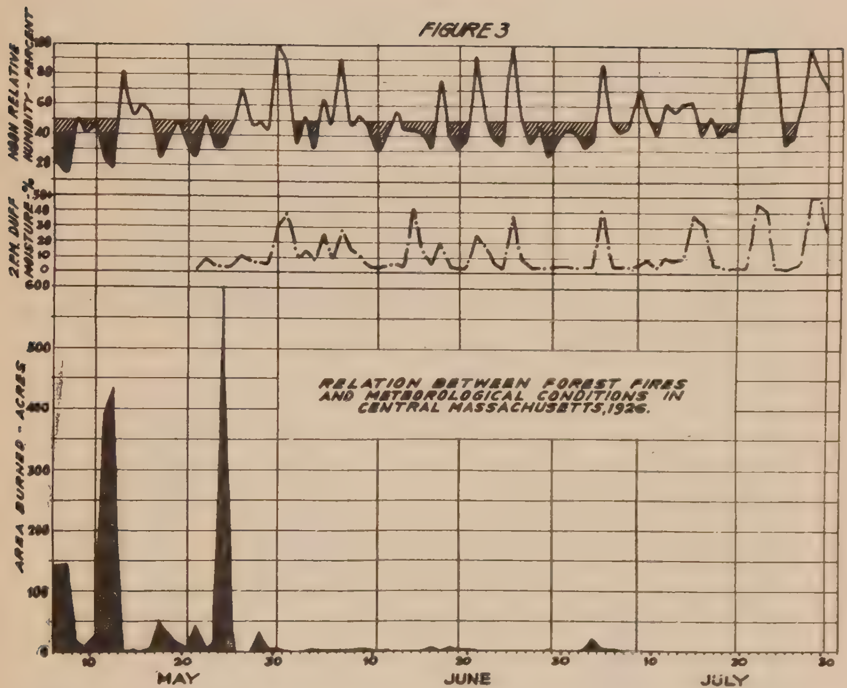
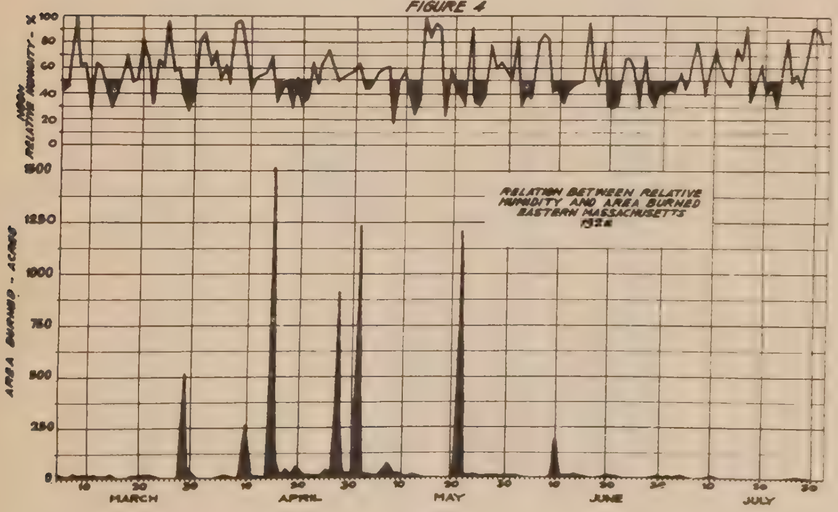


FIGURE 4



Relative Humidity and Fire Hazard Related

Since there is a very close correlation between relative humidity and duff moisture percentage, it should follow that there is a relationship between relative humidity, forest fire occurrence, and frequency of forest fires. A comparative analysis of the noon relative humidities and the forest fire records for central and for eastern Massachusetts shows that this relationship does exist (Figures 3 and 4). For central Massachusetts the relative humidity records of the forest fire weather station at Petersham were used, while for eastern Massachusetts it was necessary to use the Boston humidity records. In spite of the fact that Boston is more than one hundred miles away from the area of forest fires in eastern Massachusetts, the relationship between weather and fires is very pronounced.

In examining the graphs of relative humidity and area burned over, two points of interest are outstanding. First, the peaks of area burned occur either on days of low humidity or follow extended periods of low atmospheric moisture content. Second, by analyzing the data presented in these graphs we obtain one of the most valuable and practical sources of information which a study of meteorological factors can give. These charts give us an expression of forest fire danger in terms of relative humidity. No allowance was made for the influence of rainfall. In the two cases presented here the zone of forest fire danger seems to occur when the relative humidity consistently falls below 50 per cent. In other words, we can expect the largest number and severest forest fires when the relative humidity falls below that percentage.

For central Massachusetts (Figure 3), 58 per cent of all the days during the spring fire season had a relative humidity of 50 per cent or less. *This 58 per cent of all the days accounted for 81 per cent of the total number of fires, 99 per cent of the area that was burned, and 98 per cent of the damage caused.*

The relative humidities given on the graph of the Cape Cod fires (Figure 4) show the same results. For this region the days with relative humidities of 50 per cent or less totaled 43 per cent of all the days. *This 43 per cent of the days accounted for 63 per cent of the number of fires, which burned 83 per cent of the area and caused 78 per cent of the damage.*

Foliage Good Protection

One of the reasons for the decrease in forest fires during the late spring and early summer is the appearance of the tree foliage. It might almost be said that the establishment of the full foliage in our forests ends the spring fire season; and the shedding of the leaves in the autumn opens the fall fire season. The leaves on the trees help to reduce the fire danger directly, since they reduce the wind velocity and prevent the sun's rays from falling on the forest floor. This materially prevents the more complete drying out of the leaf litter on the ground.

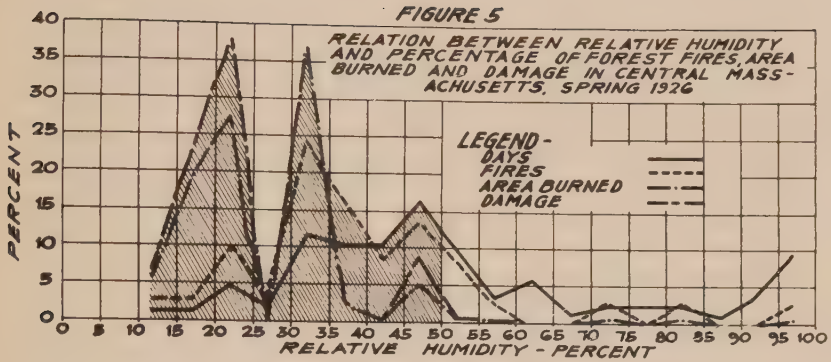


FIGURE 5
RELATION BETWEEN RELATIVE HUMIDITY AND PERCENTAGE OF FOREST FIRES, AREA BURNED AND DAMAGE IN CENTRAL MASSACHUSETTS, SPRING 1926
LEGEND -
DAYS
FIRES
AREA BURNED
DAMAGE
PERCENT
RELATIVE HUMIDITY - PERCENT
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

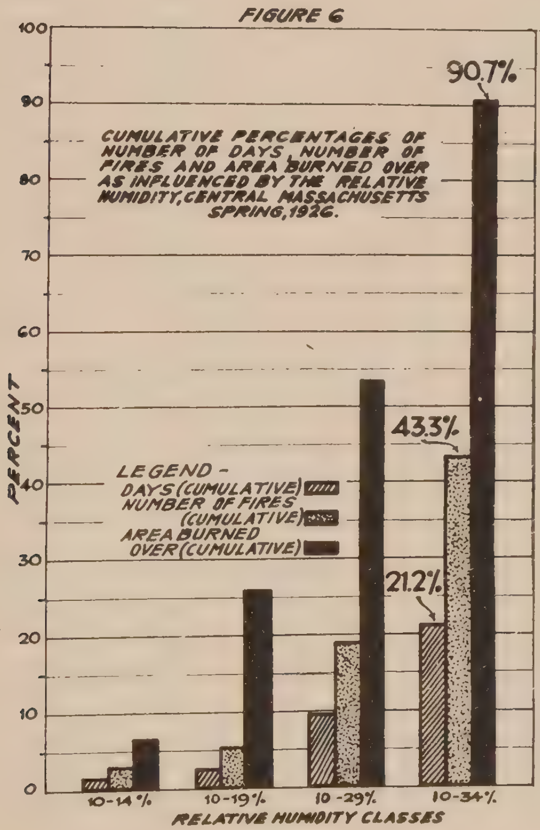


FIGURE 6
CUMULATIVE PERCENTAGES OF NUMBER OF DAYS, NUMBER OF FIRES AND AREA BURNED OVER AS INFLUENCED BY THE RELATIVE HUMIDITY, CENTRAL MASSACHUSETTS SPRING, 1926.
90.7%
43.3%
21.2%
LEGEND -
DAYS (CUMULATIVE)
NUMBER OF FIRES (CUMULATIVE)
AREA BURNED OVER (CUMULATIVE)
PERCENT
10-14%
10-19%
10-29%
10-34%
RELATIVE HUMIDITY CLASSES

Not only area burned but also the number of fires and damage caused are closely influenced by the relative humidity. By plotting the number of days within the various relative humidity classes, number of fires, area burned, and damage (Figure 5) caused we find that all of these curves follow the same general trend. For the Petersham areas studied it appears that the peak of danger occurs with relative humidities of 30 to 35 per cent. This is due, no doubt, to the fact that there are more days within this relative humidity class, and also to the fact that people are, perhaps, less careful on these days, since they think there is less danger than during the extremely dry days.

Most strikingly is the relationship between relative humidity and forest fire hazard brought out by these data when plotted on a cumulative basis (Figure 6). Such a graph cannot help convincing one of the value of the study of meteorological factors in relation to forest fire prevention. For central Massachusetts fire records the results are especially illuminating. One per cent of days had relative humidities between 10 and 14 per cent. On these days, 3 per cent of the fires occurred, which burned over 7 per cent of the area and caused 3 per cent of the damage. On days with relative humidities between 10 and 19 per cent, a total of 2 per cent of all the days constituting the spring fire season and 5 per cent of the fires, 26 per cent of the area was burned and 26 per cent of the damage was caused. Days with relative humidities between 10 and 24 per cent, a total of 10 per cent of the days and 19 per cent of the fires, accounted for 54 per cent of the area burned and 64 per cent of the damage. Days with relative humidities between 10 and 34 per cent, a total of 21 per cent of the days and 43 per cent of the fires, accounted for 91 per cent of the area burned and 88 per cent of the damage.

Meteorological Study Justifiable

To sum up briefly: Of the total number of days during the spring forest fire season in central Massachusetts, on 21 per cent of the days there was a total of 43 per cent of the fires. This relatively small percentage of fires occurred on days with relative humidities between 10 and 34 per cent; yet these fires burned 91 per cent of the area and caused 88 per cent of the damage. *Think what this means in terms of forest fire prevention! If, by means of warnings and added patrols during these days of high fire hazard, we could have reduced the number of fires by only 43 per cent, yet the area burned would have been reduced by 91 per cent and the damages by 88 per cent.* To me this is an outstanding example of the value of meteorological studies in forest fire prevention.

Before closing, I would like to point out briefly the value of meteorological studies in forest fire suppression. This is also prevention, though along a slightly different line: it is the direct prevention of

larger fires and the conservation of money and human energy expended in suppressing them. I believe that I am correct in saying that the technique of forest fire suppression in the East has not kept pace with that in the West. This may be due to two reasons: the type of wardens in charge of the suppression work and the lack of appreciation of the use of weather in fighting fires. As yet, the wardens are not convinced of fighting the fires at "zero hours." By "zero hours" I mean that period of the day during which fires no longer burn vigorously and run, but just smolder. These hours usually occur late in the evening and around daybreak. Many of the wardens do not wish to go on the fire line in the early morning or at twilight, claiming that they cannot see well enough to fight the fire. Yet it is at these zero hours that all the elements are with the fire fighters and a concentrated attack has the best chance for success. It is the period most favorable for mopping up and putting out the fire completely.

The two weekly records of meteorological factors (Figures 1 and 2) illustrate why this is. From early evening to early morning the relative humidity is on the upward trend, and reaches its highest daily level; wind velocity decreases; evaporation becomes less; and the air temperature drops. *What is most important of all is that the duff moisture increases materially.* It is during such periods that the fires no longer run, but just smolder in the duff. This, rather than during the heat of the day when all the elements are favorable for the further and rapid spread of the fire, is the favorable period of the day for the fire crews to be on the fire line.

Information Is Practicable

In the East we have just begun to appreciate the importance of the study of meteorological factors in our forest fire prevention work. The two concrete examples I have presented to you are only a few of the facts which such a study can give. You can readily see that these facts are of practical application in our forest fire prevention work. The knowledge of the use to be made of the zero hours is of incalculable value in efficient fire suppression work. An expression of fire danger in terms of relative humidity has many practical applications. Even in its preliminary form, it can be used in the issuing of burning permits. In Massachusetts a large percentage of the fires reported are caused by people with burning permits. A warden supplied with a sling psychrometer could very easily make relative humidity measurements, and during periods of low relative humidity refuse to issue permits, thus helping to reduce the annual forest fire bill.

Much remains to be done in this work. There are many problems of importance on which we have no information at all, and the solution of which will be of value. For example, we do not know definitely what the relative degree of danger is in hardwoods as contrasted to

softwoods. Under equal conditions of rainfall, how much longer is the danger deferred in a clear cutting in pure hardwoods in comparison to a clear cutting in pine, spruce, or mixed hardwoods-softwoods? What is the relative speed of the drying of the duff in the various forest types in the Northeast? In terms of degrees of inflammability what does 5 per cent, 10 per cent, and 25 per cent of duff moisture mean in the pine or spruce forests? These are but a few of the questions engaging the attention of those working on the problem of forest fire-weather. Though there are many fundamental problems still to be solved, I believe that the time will soon come when we shall have daily forecasts of forest fire danger just as we now have daily forecasts of the weather.

GRAZING AND THE WOODLOT

By SAMUEL N. SPRING,
Professor of Silviculture, Cornell University, Ithaca, N. Y.

GRAZING strikes murderously at the very heart of the woodlot in New York State. Because a woodlot does not have a warm blood stream as animals do death does not ensue at once but the ultimate result of grazing is sure and certain death to the woodlot where it is practiced continuously.

Figures for New York State as found in the 1925 Farm Census become significant indeed if the statement just made is kept in mind. They are as follows:

	Acres
Total land area	30,498,560
Land in farms	19,270,259
Land in crops	9,088,221
Woodland pastured	2,023,332
Woodland not pastured	1,781,080
Total woodland in farms	3,804,412

It appears that 2,023,332 acres out of 3,804,412 acres are on the down grade of deterioration toward final extinction because of grazing. Furthermore, the percentage of area pastured is on the increase instead of decrease.

But, you ask, "How can grazing bring about the death of the woodlot?"

Like a true Yankee I can answer that by asking another question, "How can a nation live if the little children are all killed off within a year or two after birth or are crippled for life?"

Little seedlings that spring up naturally in the forest are the next generation of timber trees of the woodlot. Grazing animals browse these back to the ground in the case of broadleaved trees and in the case of the conifers browse off shoots and needles as well as trampling and deforming the little evergreens. Of course a few may escape but not enough grow up to prevent woodlot race suicide, so to speak. A heavily grazed woodlot was given a very apt name by an investigator* in Ohio some years ago, who classed it as "The Hopeless Woodlot" in which matured trees, defective culls and weed trees formed the stand with grass on the ground beneath.

Woodlot and Pasture Incompatible

He struck a keynote when he stated that if the owner tries to combine pasture and woodlot neither will be first class, but if he divides them he will have both a good pasture and an excellent woodlot.

There are many things that contribute to the downfall of a grazed woodlot that are not evident unless one studies the conditions year by year. To understand these one needs to appreciate the conditions that are found in well managed woodlots where grazing is not permitted. Such a woodlot is well stocked with useful trees whose crowns form a complete canopy above, shading the ground and lowering evaporation of moisture from the soil. The ground beneath the trees is covered by a good layer of twig and leaf litter which as it gradually decays underneath adds fertility to the soil.

*W. R. Matton has summed up the amount and value of this fertilizer as follows:

"In this article on 'The Conservation of Fertilizer Materials from Minor Sources,' in the Agriculture Yearbook for 1917, C. C. Fletcher, associate chemist of the U. S. Bureau of Soils, gives the percentage of fertilizer materials contained in oak leaves. According to his figures a ton of oak leaves contains fertilizer materials as follows:

	Pounds
Nitrogen (or ammonia) (NH_3)	16
Phosphoric acid (P_2O_5)	7
Potash (K_2O)	3

Mr. Fletcher recently stated that pine needles contain approximately the same amounts of these materials as oak leaves. On the basis of experience in hauling away the yearly accumulation of four oak trees growing in Maryland, just outside the District of Columbia, I estimate that on one acre well stocked with mature oak two tons of leaves are deposited yearly. It is likely that pines shed less, also the intolerant trees such as the ash, black walnut, and black locust. The very tolerant beech is known to have a very heavy foliage.

How much is the yearly crop of oak leaves worth per acre? Nitrogen, or ammonia, costs the farmer at wholesale rates from 12 to 20 cents a pound, phosphoric acid about 5 to 6 cents, and potash at its present very low price about 5 to 6 cents. On this basis two tons of oak leaves have a fertilizer value as follows:

Nitrogen	16 lbs. × 2 = 32 lbs. @ 15¢ = $4.80
Phosphoric acid	7 lbs. × 2 = 14 lbs. @ 5¢ = .70
Potash	3 lbs. × 2 = 6 lbs. @ 5¢ = .30

Thus the yearly crop of oak leaves on an acre is worth $5.80 for fertilizer."

* A Woodlot Survey in Oxford Township, Butler County, Ohio, Miami University Bulletin, Series X, No. 11, 1912.
* The Forest Worker, page 27, March 1926.

Soil Fertility Lost by Grazing

Grazing slowly but surely changes conditions, more rapidly if many animals occupy the woodlot.

The soil is trampled and packed, roots of shallow rooted trees become exposed and as mature and overmature trees come down or are cut out with none to replace them the litter disappears and grass replaces it. These grasses growing in the partial shade lack great nutritive value and steal food and moisture from the trees. As the forest grows more open the wind may uproot trees and there are no younger ones to fill the gap and so the process goes on. The ground loses fertility being robbed of its litter that releases plant food in decaying.

In the maple sugar industry it has been found that the sap run is best from ungrazed maple woodlots. Good sap depends on the greatest vigor of the trees which in grazed woodlots are deprived of the natural fertilizer supplied by the litter and lack an abundant supply of moisture from the soil because of the drain by grasses, the increased evaporation from the soil and the tendency of sod to keep water from entering the soil freely.

From the standpoint of growth of wood a grazed woodlot is lowered in its productive capacity, first because it is steadily reduced in number of trees lessening total quantity and second because growth slows down with the conditions of food supply changing for the worse rather than the better.

Grazing of woodlots is beneficial from the owner's standpoint in furnishing shade to the animals and some food but he loses the possibility of good returns from the woodlot, in exchange for relatively small benefits.

A common sense procedure would be to fence off the woodlot excepting such a portion as will afford the shelter required. The owner should decide what proportion he needs for wood production and manage it as intensively as he would any other crop.

Grazed Land May Be Improved

The question naturally arises whether a woodlot will come back after being subjected to grazing. There are plenty of examples. At Cornell in the management of the University woodlots an experiment in shutting out grazing from a part of the Veterinary College woodlot and permitting it in adjoining parts has been in progress for a little over 10 years. Conditions have steadily improved in the protected portion and skillful cuttings have given rise to a carpet of useful young trees which will form the basis for a new crop as mature trees are removed in the future. The grazed part has steadily deteriorated in marked contrast to the part protected.

The first most vital step in forestry on the farm woodlot is to exclude grazing animals and to devote all or part to wood production, a

crop well worth the owner's attention and one that will repay him in money and in other ways.

Prof. R. M. Adams, in a rhyme entitled, "They Don't Mix," has put the matter of grazing and the woodlot as follows:

"The man who likes a good tree stand should not use woods for grazing land. A real good gardener sometimes can, by being careful of his plan and going to some extra trouble, make one small space do duty double, have parsnips close to spinach greens and sweet corn interrowed with beans. According to Professor Cope, who writes our college forest dope, for pastures and for growing wood this double use is not so good. The soil throughout the forest tract by trampling feet is tightly packed. No longer fit for good tree seeds it nurtures only brakes and weeds. The oak that fain would reproduce says, 'My good gosh, it ain't no use. Behold each seedling of my heart, chewed off before it gets a start.' The moral's pointed pretty slick within a well-known limerick. 'A smiling young lady of Niger went out to ride on a tiger. They came from the ride with the lady inside and the smile on the face of the tiger.' The trees are sad where cattle browse; the smiles are all upon the cows."

PROTECTION OF FOREST PLANTATIONS IN NEW YORK STATE

By C. R. Pettis,

Superintendent of State Forests, New York State Conservation Commission

IT is a rather hard matter to speak on this subject without covering some of the points of previous speakers or those whom you are awaiting the pleasure of hearing, because the protection of forest plantations relates not only to the human causes of fires, but to the various insects and fungous diseases.

To my mind, if we can discover a fire in its incipient stage, it can be quickly extinguish without very much loss; and if the Gipsy Moth can be definitely located, it can be treated and controlled; and the white pine blister rust is simply a problem of selling the idea to the owner of the land to clean up his currants and gooseberries.

The factor that worries me most is the question of not discovering the fire before it gets beyond control; or some of the scouts skipping a cluster of Gipsy Moth eggs; or some land owner who does not appreciate the importance of blister rust and the means by which it can be controlled. In carrying this thought a step further, I feel that the State and the Federal government is not building a foundation for the future as it should.

I want to stress the point that it is not the things that we find and know about that are of the greatest importance in the protection of the forest plantations in the State, but it is the things that are not discovered until it is too late, that is the real problem. My idea is that with all of our forest resources and industries and idle land, and the effort that is being put into reforestation and forest management, deserves far greater investigation into our insect pests and into our fungous diseases, and that we should be at all times alert and trying to solve these problems before they become a real menace.

Investigation Always Needed

In 1909 when blister rust was first discovered as a forest plantation pest, neither the foresters nor the pathologists knew how to handle this question, but today it is simple, because the whole life history of the disease has been worked out and the methods of control have been devised. We need a sufficient number of forest pathologists and forest entomologists to be anticipating what are going to be our problems in the way of insect infestations and of pathological forest injuries, and

make thoro field and laboratory study of these, learning their life histories and devising in advance methods for their control. We all know that any one of these infestations jeopardize the value of forest property, and are often hard to control, costing a large sum of money. Therefore, a small amount of money for investigation in advance to ascertain the plans for the control, when necessary, is going to be a great saving in forest property and of money to the State and Federal government in the control of these pests.

We should also have greater public sentiment against trespass upon private land, deliberately pulling up trees belonging to others, in some cases throwing them on the running board or the radiator of the automobile and carrying them home to plant, whereas as a matter of fact these trees usually die within a very short time because they are not properly taken up or properly protected in transit. They are destroying values in plantations and not themselves getting anything in return. They may at the same time be unwittingly transporting diseases or insect pests from one section of the country to another.

Law Should Be Changed

I think there should also be a modification of the new Federal Horticultural Board Quarantine No. 63 on inter-state shipment of white pine, and that if necessary a law should be enacted by Congress prohibiting the inter-state movement of any trees or shrubs from one State to another without the consent of the State into which they are to be moved. We all know that some of our most serious problems have resulted by lack of care in this connection, and to my mind it is impossible to understand why one State should be made the dumping ground of plants from some other State in order that some man in the other State can profit by so doing and at the same time injure his neighboring State.

I do not want to appear as trying to discourage anyone who is interested in reforestation work, but I simply want to add these words of warning or caution, not because I think that the matter in most cases is of such serious moment to our present plantations, but rather that I believe that we should plan and fortify ourselves for the future safety of our investments in forests plantations and in wood crops.

FIRE SUPPRESSION IN NEW YORK

By William G. Howard,

Assistant Superintendent of Forests, New York State Conservation Commission

"MOST people are not only willing but anxious to help prevent forest fires but do not know how," said William G. Howard, assistant superintendent of forests for New York State and chief of the state forest fire-fighting forces.

Mr. Howard made a plea for public education in forest fire prevention. After telling many ways in which this has been done, he said the most effective education had been accomplished by the Governor's proclamation in the fall of 1924, which closed the entire Adirondack region to sportsmen. The proclamation was issued during the latter part of the fire season, which happened to lap over into the hunting season.

"This proclamation carried home to each sportsman the importance of the forest fire situation," said Mr. Howard, and gave notice to the public particularly to the sportsmen that unless fires were prevented the great Adirondack park would be locked up and the opportunity for hunting, fishing, camping and other forest recreation would be lost.

Mr. Howard said that fires in the forest preserve are no greater in number than before the system of fire prevention was established in spite of the tremendous increase of campers and tourists entering the forests in recent years. There has been a steady decrease, he said, in land burned since 1903 and the average acreage burned has been reduced from 478 acres per fire to 25. These results have been obtained chiefly through the excellent observation tower system intensively established in the forest preserve.

The average acreage burned over each year in the Adirondack and Catskill regions has been reduced to less than 10% of what it was just prior to 1909, so that at present there is only about one chance in a thousand of a given area of land being burned over in any one year. A degree of hazard which it is claimed is an insurable risk and as such justifies investment in forest plantations and growing forests in New York State.

Progress made in fire prevention and suppression since the establishment of the present system was emphasized in the summary with which the talk concluded. The completion of a system of 64 standard fire observation stations, equipped with steel towers and with telephone

lines of standard construction connecting nearly all stations with commercial telephone lines, and the development and acquisition of equipment of the best sort, devised primarily for fighting forest fires were touched upon in the fire chief's concluding remarks. He said the area to which the protection work is applied has been nearly doubled under the regime of the Conservation Commission.

PREVENTION, PREPAREDNESS AND SUPPRESSION

By Major E. W. Kelley,

District Forester, District No. 7, United States Forest Service

THE impossibility of obtaining Major Kelley's paper in full compels the publication of only a few passages as they were recorded during the delivery of his address. He said in part:

"It is *management* in the largest sense of the term that is needed quite as much as money and men. Management of that order is required that will get from available resources in men and money more productive efforts measured in terms of fewer man-caused fires and more consistent progress in the reduction of area burned, despite the bad year — the year when nature withdraws her aid and leaves man to combat risks and stop the spread of flames with the application of his own skill in fire control technique. Management of that order can come only through a higher developed art of fire control. Art in fire control consists very largely of good management of men and other facilities.

"The point at which to start the upbuilding of managerial capacity in fire control organization, in my judgment, is first to build up a better understanding of the more important of the fundamental principles underlying fire control in its three phases, *prevention*, *preparedness* and *suppression*. * * *

"Adequate protection against fire — a term very generally used — may be defined as control of fires developed to a point at which forest resources are accepted as an insurable risk in the underwriters' world.

"I have nothing new to advance as to means that should be adopted and applied in order to bring about an adequate measure of fire control. It is my thought, however, that there is a real need for the development of a store of new ideas as to how known means may be more effectively applied. In this I speak from the standpoint of experience of the Federal Forest Service, where knowledge of what should be done, generally granted, is in advance of altogether a satisfactory standard of performance, and to a degree that is giving the Forest Service genuine concern.

"The United States Forest Service has reached the point at which it believes that it needs to take stock of performance, then to develop from such an inventory a course of training designed to develop a better mastery of the problems — a higher standard of management."

The New York State College of Forestry

Syracuse University